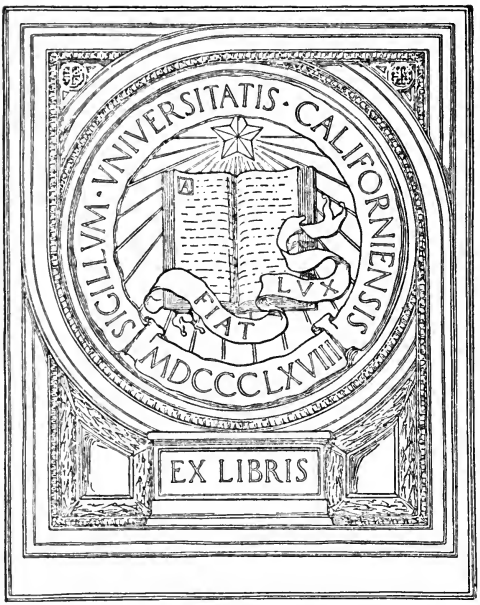
State Crop Pest Commission OF Louisiana.

FIRST BIENNIAL REPORT
OF THE SECRETARY
1904-05.



STATE

CROP PEST COMMISSION

OF

LOUISIANA

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FOR THE YEARS

1904 AND 1905

TO THE GOVERNOR

BATON ROUGE:
THE TIMES, OFFICIAL JOURNAL OF LOUISIANA.
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LETTER OF SUBMITTAL.

To His Excellency, Newton C. Blanchard, Governor of Louisiana:

SIR:—I have the honor to submit herewith, a report upon the work of the State Crop Pest Commission, established by Act No. 6, of the Extra Session of 1903, for the years 1904 and 1905; together with a statement of the results obtained by the enforcement of quarantine regulations preventing the artificial dissemination of the boll weevil and the San Jose scale; the results secured in the investigation of entomological problems of immediate importance to the agriculture of the State, and an outline of the work at present under way and contemplated for the coming year.

Very respectfully,

WILMON NEWELL,

Secretary.

Baton Rouge, La., February 15, 1906.

State Crop Pest Commission

OF

LOUISIANA

OFFICE OF THE SECRETARY.

Baton Rouge, La., February 15, 1906.

The discovery, in July, 1903, of the boll weevil in a cotton patch upon the grounds of the Audubon Park Experiment Station, at New Orleans, forcibly attracted the attention of the entire State to a new danger which threatened the future success of her most important crop.

The Special Session of the Legislature which convened in December, 1903, passed an Act establishing the State Crop Pest Commission, to consist of the Governor of the State, the Commissioner of Agriculture, the Director of the Louisiana State University Experiment Stations, two practical cotton planters and the Entomologist of the State Experiment Stations. The Act creating this Commission wisely vested in it the power of making and enforcing quarantine regulations to prevent the introduction and dissemination of dangerous insects and diseases of crops and fruits, and to investigate and devise remedies for such.

This law has proved to be, undoubtedly, the most conservative, yet far-reaching, practical and effective law for the control of crop pests and diseases that has ever been adopted in any state or country.

Following the approval of this Act, the Commission organized and held its first meeting at Baton Rouge on February 5, 1904.

At this meeting Prof. H. A. Morgan, Entomologist of the State Experiment Stations, was elected Secretary of the Commis-

sion, and quarantine regulations looking to a prevention of the further progress of the boll weevil into Louisiana territory were adopted and at once placed in effect.

1904

The work of the Commission during 1904 was entirely under the direction of Prof. H. A. Morgan.

At the beginning of the year the only territory in Louisiana known to be infested by the boll weevil was in western Sabine Parish. This infestation the Commission exterminated by inducing the farmers in the affected territory to abstain from the planting of cotton during 1904, the planters and farmers being paid a cash rental for the acreage thus 'thrown out'' of cotton during that season.

An infestation discovered near Logansport in July, 1904, was also exterminated. More particular references to these are made in Circular No. 5 of the Commission, copy of which is submitted herewith.

In August, 1904, Prof. Morgan discovered that the boll weevil, in addition to being disseminated artificially in hulls, cotton seed, etc., possesses a migratory habit, which manifests itself during late summer and autumn. This migration of the weevils, during the summer and autumn months of 1904, carried the infestation again into the territory where the pest had been exterminated, and, in addition, gained for it about twenty miles to the eastward. The discovery of this habit of the insect entirely revolutionized the methods to be employed in limiting the weevils' progress, and the quarantine regulations, which had previously been enforced to the extent of causing serious inconvenience to business interests, were supplanted by regulations fully as effective in preventing the artificial spread of the weevil and entailing no loss to individuals or business interests.

These regulations have, up to the present time, been entirely effective in preventing the weevil from obtaining a foothold in Eastern and Northeastern Louisiana. Had it not been for the enforcement of these regulations there can be but little doubt that there would now be many local centers of infestation in the area (four-fifths of the State) still free from this pest.

During the summer and autumn months of 1904, the en-

tomologists of the Commission, in co-operation with the Special Field Agents of the Bureau of Entomology, United States Department of Agriculture, made numerous field examinations in studying the previously unknown migratory habit of the weevil, in determining the territory infested, in investigating the results obtained by planters in the use of Paris green against the boll weevil, and in disseminating information among planters and farmers in the infested territory.

1905

Following the resignation of Prof. H. A. Morgan, in February, to accept the Directorship of the Tennessee Agricultural Experiment Station, the writer was elected to succeed him as Entomologist and Secretary of the Commission.

Early in the year plans were made for field demonstrations in the growing of cotton by the cultural system in the weevil-infested sections, for studying closely the migratory habits of the weevil, for testing Paris green and other substances as remedial agents against the weevil, as well as for investigations of insects injurious to crops other than cotton. All of this work required the almost constant movement of the Entomologist and his assistants from one neighborhood to another and from plantation to plantation. The yellow fever quarantines during August, September and early October made the continuation of this work impossible. Although attempts were made to continue the field work in spite of the quarantines, it was soon found that this incurred the marked displeasure of citizens in the localities visited, and field work, accordingly, had to cease. This "break" of over two months in the field observations and experiments severely crippled the work of the Commission, and a number of experiments which were being conducted with promise of giving valuable results had to be abandoned. However, in spite of the obstacles encountered, the Secretary feels that the results obtained in the field and experimental work have amply justified the expense, and that the amounts thus invested will be repaid many fold in the decreased insect damage to various crops, made possible by the application of the information gained in this work. Particular mention of the different lines of work conducted and matters of interest follow.

CO-OPERATION WITH THE BUREAU OF ENTOMOLOGY.

In view of the fact that the retardation of the boll weevil's progress eastward is of vital importance to the entire cotton-growing area of the country, the United States Department of Agriculture, Bureau of Entomology, early in 1904 very generously offered to co-operate with the State Crop Pest Commission in the boll weevil investigation, demonstration work, etc. This co-operation has continued through both 1904 and 1905, the utmost harmony prevailing between the employees of the Bureau and of the Commission. The Secretary of the Commission has been freely granted the advice and counsel of both Dr. L. O. Howard and Prof. W. D. Hunter, and, in addition, the Bureau has contributed very materially to the expense of the work in Louisiana by paying the salaries and traveling expenses of a part of the Commission's working force. In its co-operative work with the Commission during 1904, the Bureau expended $7,884.03, and during 1905, $3,959.90. This has meant, of course, a corresponding saving of the funds appropriated by the last Legislature for the work of the Commission. No plans have as yet been made for co-operative work with the Bureau of Entomology during the coming fiscal year, such co-operation being dependent upon congressional appropriations and upon the pleasure of the Honorable Secretary of Agriculture. Without the co-operation of the Bureau this year, the expenses of the Commission will be correspondingly increased

BOLL WEEVIL QUARANTINE.

As referred to above, and as pointed out in Circular No. 5 of the Commission, the extermination of isolated sporadic outbreaks of the boll weevil, when these outbreaks occur (as did the Audubon Park outbreak of 1903) outside the area of yearly migrations, is both possible and practical, and during 1905 the Commission has held itself in readiness to promptly suppress and exterminate any outbreak which might occur in Eastern or Northern Louisiana.

The Commission has received the hearty co-operation of the farmers in the non-infested territory, and numerous reports of

the weevil occurring in this territory have reached the Commission. All such reports were investigated, usually by personal visits to the localities and by actual examination of the cotton fields supposed to be threatened by the pest. In all cases the reports were found to have been occasioned by other insects. As not a single case of infestation has been found in the eastern portions of the State, the quarantines maintained by the Commission may safely be assumed to have saved those sections many thousands of dollars on the cotton crops of the next few years.

As the cotton-growing section of the State east of the Mississippi River is not likely to suffer severe weevil damage within the next three or four years, and as Northeastern Louisiana will not be reached by the weevil in its natural spread for six or eight years, the advisability of protecting those sections from artificial or accidental introduction of the boll weevil in the meantime, by regulations such as have already proven effective, must be self-evident.

The boll weevil quarantines maintained by the Commission, and their operation, are discussed in Circular No. 5, copy of which is attached.

CULTURAL EXPERIMENTS AND DEMONSTRATIONS.

The excessive rains of early summer resulted in the overflow of several experimental plats of much importance, and during midsummer the quarantines prevented the assistant entomologists from giving personal attention to the field experiments, so that the results were by no means as satisfactory as had been expected. They did demonstrate, however, the material increase in cotton production in boll weevil sections, made possible by the use of early-maturing varieties of cotton, proper use of fertilizers and thorough cultivation.

In the spring of 1905 the Commission distributed King cotton seed to a number of farmers in Sabine Parish, and in December obtained from these same farmers their cotton acreage and production. For comparison, similar data were obtained from other farmers who did not use early varieties or attempt to follow the "cultural methods." These records show that those

farmers who followed, essentially, the cultural measures urged by the Commission, made upwards of 90 per cent more cotton per acre than did those farmers in the same locality who used "native" seed and adhered to their former plan of planting a larger acreage than could be properly cared for with the labor at their command. This success, on the part of individual farmers, in applying the cultural methods, with a resultant increased production of over 90 per cent, is most encouraging. By continuing an active educational campaign among the planters and farmers and by continued field demonstrations the Commission can undoubtedly bring about the general adoption of the cultural remedy, with a resultant saving of at least as large a per cent of the crop as that saved by the farmers of Sabine Parish referred to.

The cotton crop of the parishes in which the boll weevil at present occurs (Bossier, Caddo, Calcasieu, Cameron, De Soto, Grant, Natchitoches, Rapides, Red River, Sabine, St. Landry, Vernon and Winn) during the years 1899 to 1903, inclusive, averaged 263,565 bales per year, which at $50.00 per bale may be considered as worth in the neighborhood of $13,178,000. Assuming that, without the adoption of the cultural remedy, the boll weevil will reduce this yearly crop but 50 per cent (and it is likely that the reduction, under such circumstances, would be much greater than this), the annual crop of this territory will be reduced to 131,000 bales. The farmers in these parishes can apply the cultural remedy with at least as good results as did the Sabine Parish farmers mentioned above, and the general adoption of the cultural remedy in these parishes will therefore result in a *saving* of *at least* an amount equivalent to 90 per cent of the 131,000 bales, or 118,000 bales per year, worth in the neighborhood of $5,900,000.

Perhaps the greatest obstacle with which the Commission has to contend, is the prejudice which some farmers have towards "scientific" work and methods. Failing to realize that true science is nothing but the plain unvarnished *truth,* they attempt to disparage what they are pleased to call "book-farming." This unfortunate obstacle to a universally successful campaign against the boll weevil can, and must be, overcome by edu-

cational work, as carried out by the Commission in a liberal distribution of literature, in addresses before agricultural meetings, and in actually demonstrating in the field that cotton can be profitably grown in spite of the boll weevil.

EXPERIMENTS WITH PARIS GREEN.

Early in the season plans were made for conducting thorough tests of Paris green as a remedial agent against the boll weevil. These experiments were made in large cages constructed for the purpose near Keachie, La., and also in the open field. The application of the poison, as well as amounts, dates of applications, etc., was directed by Hon. B. W. Marston, a member of the Commission, and the observations upon effectiveness, as well as the records of production of the different plats in the experiments, were made by Mr. J. B. Garrett, Assistant Entomologist. Mr. Garrett's results in connection with the cage experiment were afterwards verified by a committee of prominent cotton planters who visited the experimental cages and made a searching investigation of the experiment.

In the vicinity of Keachie the weevils did not emerge from hibernation until after the young cotton had commenced putting on squares, and therefore no opportunity was had of testing the effectiveness of the poison when applied prior to the time of squaring. Applications of Paris Green, in various amounts, gave results* which showed the use of the poison in late summer, so far as the boll weevil is concerned, to be not only unprofitable, but to actually result in decreased production through injury to the cotton itself.

OTHER EXPERIMENTS.

A number of other investigations in connection with the boll weevil have been made, among which may be mentioned the

*In the cages, cotton not poisoned and in which the boll weevils were allowed to breed unmolested, produced at the rate of 676 pounds of seed-cotton per acre; cotton to which a total of 2 7-8 pounds of Paris green per acre was applied produced at the rate of 525 pounds seed-cotton per acre, while the cotton which received a total of 10 3-4 pounds of poison per acre produced only 406 pounds of seed-cotton per acre.

In the "field experiment," in which Paris green was applied to cotton in the open field, poisoned cotton which received three separate applications of two pounds per acre each, produced 203 pounds of seed-cotton per acre. Unpoisoned cotton, in a field adjoining, produced 565 pounds per acre. All these experiments were upon hill land.

successful fumigation of cotton seed with hydrocyanic acid gas at a strength that will kill all boll weevils, but which will not impair the germinating power of the seed. This method, while too expensive to employ in a commercial way at present, is being employed in the fumigation of seed of early varieties of cotton from the weevil-infested territory when it is necessary to take this seed to the non-infested sections for experimental or demonstration work. The danger of disseminating the weevil with such seed is thereby eliminated.

COTTON SEED OIL MILLS.

During the past year the Commission has devised a method by which cotton seed oil mills can handle their hulls, after these leave the huller, in a manner which will effectually prevent the dissemination of boll weevils with them. To oil mills in the infested territory, arranging and screening their shakers and conveyors in the manner required by the Commission, permits are given for the shipment of hulls to the non-infested territory. This arrangement permits an unhampered outlet for the hulls without endangering the localities through which, or to which, the hulls may go.

THE SAN JOSE SCALE.

As mentioned on a previous page, the State Legislature, when enacting the Crop Pest Law of the State, very wisely provided for the control of insect pests other than the boll weevil. Up to the present time the damage by the latter insect, in Louisiana, has not exceeded that done by the San Jose scale, a serious enemy of such fruits as peach, pear, apple, plum, etc. This insect and its destructiveness, the remedies for it, etc., are discussed in Circular No. 4 of the Commission, copy of which is appended.

NURSERY INSPECTION.

Realizing the necessity of preventing additional introduction of the San Jose scale upon shipments of nursery stock from other States, and the necessity of preventing further dissemina-

tion of this pest from Louisiana nurseries, the Commission, at its meeting March 15, 1905, adopted regulations requiring the inspection of all Louisiana nurseries at least once a year, the attaching of official certificates of inspection to all shipments of nursery stock coming into the State and the attaching of the Commission's certificate of inspection to all nursery stock sold or shipped by Louisiana nurseries.

The Entomologist and his assistants, during the summer and autumn, inspected all fruit tree nurseries known to exist within the State, twenty-nine in all. Of these, twenty-eight have received certificates allowing sale of the trees and plants grown by them. In the case of thirteen of the twenty-seven nurseries, inspection revealed the presence of San Jose scale either in a portion of the nursery or upon the premises in such position as to endanger the stock being grown for sale. In all cases but one, the owners of these infested premises and nurseries immediately followed the suggestions of the Entomologist for eradicating the pest. The scale was successfully eliminated in the case of twelve nurseries, the owner of the remaining one being too indifferent to the interests of his customers to undertake the eradication of the pest, and he was accordingly refused a certificate.

The twenty-eight nurseries which received certificates, produced healthy, marketable trees and plants as follows:

Peach	248,172
Apple	138,000
Pecan	93,663
Strawberry plants	50,000
Pear	42,000
Field-grown rose bushes	*26,300
Plum	16,619
Orange	15,600
Grapes	8,000
Forest and shade trees	**5,911
Fig	3,300
Privet	1,000

*Includes only field-grown rosebushes for sale as such, and does not include roses grown in greenhouses or by florists.

**Does not include catalpa trees propagated or grown on catalpa plantations.

Citrus trifoliata	***350
Ferns	****350
Camelias	****175
Magnolias	162
Arbor vitae	100
Palms	****50
Miscellaneous	33,800
Total	683,552

In order that the purchasers of trees and plants may be properly protected against uninspected trees (which are frequently infested with dangerous insects or diseases) the Commission requires a copy of the inspection certificate attached to each shipment and delivery of trees. The twenty-eight nurseries holding certificates have used, in the disposition of the above stock, 27,500 "certificate tags." These tags, having the official certificate of inspection printed upon them, are prepared under the supervision of the Commission in order to guard against fraud, but are furnished to the nurserymen at the actual cost of printing which, for the season, has averaged .18 cents per 100 tags.

In addition to the inspection and supervision of the Louisiana nurseries, the Entomologist and his assistants have made frequent inspections of nursery stock shipped into the State, and have seen that common carriers, as well as nurserymen of other States, comply with the Commission's regulations (copy of which will be found in Circular No. 4).

Shipments coming into the State, found infested with San Jose scale or other seriously injurious insect or disease are promptly confiscated and burned up.

That these measures are conducive to the best interests of the fruit industries of Louisiana is attested by the hearty support and commendation given the work of the Commission along this line, by all the nurserymen and florists of the State, as well as by the State Horticultural Society, fruit growers' associations, etc.

***Does not include trifoliata stocks held by nurserymen for budding purposes.

****Does not include plants of these sorts grown in greenhouses or by florists.

ORCHARD INSPECTION.

At the request of owners, the Entomologist and his assistants have, during the year, inspected twenty-two orchards for San Jose scale and other insect pests. These orchards contained approximately 86,400 trees. In seventeen out of the twenty-four orchards San Jose scale was found, and in one of the orchards the West Indian peach scale was discovered. In all such cases the owners were given directions for bringing these pests under control.

The Commission has not condemned or destroyed any orchard trees on account of infestation by this pest, as it is the aim of the Commission to save property, not to destroy it, and means of fully controlling the San Jose scale economically are available. Where nurseries are infested, however, the imminent danger of the pest being disseminated upon the stock makes destruction of all infested trees and plants absolutely imperative. Not even in the case of infested nurseries has it been necessary to condemn stock, as the owners, with one exception, have been quick to see the damage that would result to their customers if this pest were sent out with their trees, and they have been ever ready to act promptly upon the suggestions of the Entomologist whenever ~~such~~ steps for the eradication of this enemy were necessary.

CATTLE TICK INVESTIGATION.

Prof. H. A. Morgan, prior to becoming Entomologist of the Commission, by careful studies of the life-history of the Texas fever cattle tick, devised a successful method of eradicating this destructive pest from farms and plantations. This work was continued by Prof. Morgan during 1904, and his excellent results were presented in Bulletin No. 82 of the State Experiment Stations.

Much remains to be learned concerning the different stages of development of the tick under different conditions and in different localities. This work is being carried on by the Commission in co-operation with the State Experiment Stations. Valuable data has already been obtained, and it is hoped that within a year the Commission will be prepared to undertake the extermination of the tick over considerable areas, in order that stockmen may ship to northern markets and show-rings without

experiencing the annoyance occasioned by the present federal quarantine upon cattle from the tick-infested portions of the South.

Tick extermination will mean not only more rapid growth of young animals and the rapid putting on of flesh, but will also mean the complete elimination of Texas or "acclimating" fever.

INVESTIGATION OF HORSEFLIES AND DEERFLIES.

Next to the cattle tick, the horseflies and deerflies have been among the greatest obstacles to profitable live stock production in Louisiana. These pests, by sucking blood from both cattle and horses, very quickly reduce the animals in flesh and make growth and gain in weight impossible during the late summer and autumn months in those localities where abundant.

The horseflies are very closely identified with the spread of anthrax, or charbon, which disease in some years kills many hundreds of animals in the State, and also claims an occasional human being among its victims. In localities where horseflies are numerous, outbreaks of charbon have been invariably followed by a rapid spread of the disease. Dr. W. H. Dalrymple, Veterinarian of the State Experiment Stations, regards the dissemination of charbon by these insects as of equal importance with its dissemination and transmission by the ingestion of infected grasses or foodstuffs. Certain it is, that the occurrence of horseflies in large numbers coincidently with charbon outbreaks, makes the limitation and control of the disease much more difficult than it otherwise would be. The intimate relationship existing between these insects and the spread of charbon but adds emphasis to the importance of devising means by which these pests may be reduced in numbers.

Very few groups of insects present as many difficulties in the determination of life histories as do the horseflies. Most species appear to require in the neighborhood of a year for their growth from egg to adult. The habits of one species and the development of its larvæ may be entirely different from those of all other known species, so that each step in the growth of each species has to be worked out slowly, step by step, before

the knowledge necessary for the control of the insect is obtained

As a preliminary step in attempting to find measures of relief from the damage caused by these insects, the Commission during the year co-operated with the Gulf Biologic Station in a preliminary investigation of the horseflies and deerflies, securing, during the months of June and July, the services of Prof. Jas. S. Hine, a well-known authority upon this group of insects. The work done by Mr. Hine has given us numerous interesting and valuable facts, many of which are given in his report (Circular No. 6 of the Commission). Although several seasons of painstaking study will have to be given these flies before satisfactory means of control will be possible, nevertheless, Mr. Hine's investigation has brought to light the possibility of utilizing some of the natural enemies of this group of insects and the prospects for successfully introducing these natural enemies into sections of the State where they do not now occur, appears very good.

ORANGE INSECTS.

The orange growers of Louisiana have annually lost a considerable per cent of the orange crop through the attacks of orange-infesting insects, of which there are many species, principal among them being the white fly and the purple scale.

In co-operation with the Florida Experiment Station, the Commission is undertaking the introduction into Louisiana orange groves of two fungous diseases which are quite effective in controlling the white fly in the Manatee section of Florida, and which, it is thought, will be particularly effective in the moist atmosphere of our coast sections. While considerable labor and expense is involved in this introduction, it is felt that the chances for the experiment proving successful are amply sufficient to justify making the attempt.

The requests for information regarding methods of controlling orange insects have exceeded, proportionately, the requests for information regarding the insects of any other crop grown in the State, cotton not excepted.

Investigations of the more important orange insects are at present being undertaken by Mr. E. C. Cotton, Assistant Ento-

mologist, and plans are being made for experiments in the fumigation of young citrus trees of various kinds in order that means may be devised for preventing the dissemination of various scale-insects upon young orange and similar trees.

PUBLICATIONS.

In October, 1905, an "Open Letter" to the farmers of Western Louisiana, giving the principal steps included in the cultural remedy for the boll weevil and calling attention to the importance of the fall destruction of cotton plants, was issued in an edition of 10,000 and distributed through the boll weevil infested portion of the State. This publication received most favorable comment, not only from the cotton planters themselves, but also from various cotton interests in Louisiana and adjacent States.

In November, Circular No. 3 was issued in an edition of 10,000 copies. The co-operation of merchants in the smaller towns throughout the boll weevil section was secured in distributing this Circular among the farmers. Before the first edition had been completed by the printer, requests for upwards of 11,000 copies had been received and a second lot of 10,000 was ordered printed. This last edition is already exhausted, and at least 5,000 more copies will be needed within the next few weeks.

In December, Circular No. 4, describing the San Jose scale, and giving means of detecting and controlling it, etc., was issued in an edition of 15,000 copies, and distributed to nurserymen and fruit growers, as well as to the mailing list of the State Experiment Station. A second edition of 5,000 was found necessary, but owing to the universal interest in fruit growing in all sections of the State the demand for this Circular makes necessary a third edition of at least 5,000.

Circular No. 5, January, 1906, entitled, "The Work of the State Crop Pest Commission with the Boll Weevil," has been prepared primarily for the purpose of giving the farmers in the boll weevil section a clear understanding of the nature of the work being done by the Commission, the damage threatened by the boll weevil unless proper measures are adopted, etc., in order that additional co-operation with the Commission may be en-

couraged. While not giving, directly, any remedial measures for the weevil, it is believed that the plain statement of the situation and the necessity of adopting the cultural remedy, given in this Circular, will go far towards removing the unfortunate prejudice which exists in some sections, towards all scientific and educational progress. This Circular is being distributed in an edition of 32,000, most of these going to the boll weevil infested section for distribution by bankers and merchants.

Circular No. 6, now in course of preparation, gives the results of Mr. Hine's investigation of the horseflies and deerflies in Southern Louisiana, made in co-operation with the Gulf Biologic Station. This Circular is of interest mainly to stockmen, and will be sent to those of our correspondents known to be interested in live stock and to those making application for it. Due notice of its publication and of its contents will be given through the press of the State, so that all who are interested will have an opportunity to secure it.

OFFICE AND LABORATORY WORK.

The compiling of the publications referred to in the above paragraphs, together with preparation of illustrations for them, proof-reading, etc., has required a very considerable amount of time. The mailing of these various publications, requiring the correction of mailing lists, the addressing and stamping of many thousands of envelopes, etc., has been a task the magnitude of which can hardly be appreciated. Much of the time of the assistants during the winter months has been devoted to this distribution of literature, as well as to the compilation of notes and records made in connection with the field work during the summer and autumn.

During 1904, in reply to requests for information regarding injurious insects, in execution of the quarantine regulations, in directing the field work of the assistants, etc., 1651 letters were written. During 1905 the number of letters written was 2,426. These figures do not include circular letters and letters mailed in duplicate to various planters and fruit growers' associations, etc., which were prepared upon the mimeograph, and of which there were several hundred. Many of the letters received require

for their intelligent and satisfactory answer considerable study and reference to literature, and it not infrequently happens that letters of from five to fifteen pages have to be written in response to inquiries concerning a single insect, in order that the correspondent may be enabled to combat it successfully, safely and economically.

The writing of these letters, keeping them properly filed and indexed for ready reference, etc., has required the greater part of the time of the clerk and stenographer. The remainder of the clerk's time has been devoted to keeping itemized accounts of all expenditures made by the Commission and its employees and to securing proper receipts and vouchers supporting these expenditures. A very marked and rapid increase in the number of inquiries for information coming to the office is evident, and if this increase continues the employment of an additional stenographer will become necessary.

In the laboratory considerable microscopic and similar work is necessary in the identification of various insects that are sent in by farmers and fruit growers. In order to determine the identity of insects promptly and with certainty, and also to serve in illustrating talks before meetings of horticulturists, planters, etc., a good collection of identified insects is much needed. This the Commission is preparing as rapidly as possible, although the immense amount of routine and office work, together with the work of visiting different localities to make investigations at the request of business men and farmers, has prevented giving this line of work very much attention.

At the November, 1905, meeting of the Commission, the Secretary was instructed to transfer the office of the Commission from Shreveport to Baton Rouge, the latter being a more central location, and, in addition, being the legal domicile of the Commission; and the State Experiment Station, through its Director, Prof. W. R. Dodson, having tendered the use of office and laboratory room in the Experiment Station Building free of rent to the Commission. Had the office remained at Shreveport the coming year, much more office and laboratory room would have been absolutely necessary, requiring the payment of a rather large rental. By the removal of the office to Baton Rouge this

money can be utilized in the actual warfare against insects, and will, therefore, be expended to much better advantage than in the payment of rents.

As it has been necessary to continue answering letters of inquiry, distributing literature and attending to some field work besides, the packing and shipping of the various books, specimens, records, office and laboratory apparatus, etc., has required considerable time, and the Baton Rouge quarters have not yet been placed in condition to facilitate rapid work.

During the year a reference library has been started. The publications of various Experiment Stations and of the United States Department of Agriculture have been secured through an exchange of bulletins, and a considerable number of volumes, not available in ordinary libraries, have been purchased outright.

ASSISTANTS AND EMPLOYEES.

As mentioned above, Prof. H. A. Morgan resigned in February, 1905, to accept the directorship of the Tennessee Agricultural Experiment Station, and was succeeded as Secretary and Entomologist by the writer.

During 1904 the following Special Field Agents of the Bureau of Entomology, United States Department of Agriculture, were associated with Prof. Morgan in the boll weevil investigation in Louisiana for the periods named: Mr. R. C. Howell, from May 15 to December 31; Mr. S. E. McClendon, from May 15 to December 31; Mr. J. B. Garrett, from May 15 to October 15; Mr. A. W. Buckner, from May 16 to September 15, and Mr. E. S. Hardy, from May 15 to December 31. Mr. Harry Gustine was employed as office clerk and stenographer from March 15 to December 31. In addition to these gentlemen, local inspectors were employed from time to time during 1904 when their services were necessary.

During 1905, Mr. S. E. McClendon served as Assistant Entomologist from January 1 to February 15; Mr. E. S. Hardy, from February 10 to December 31; Mr. J. B. Garrett, from May 15 to December 31; Mr. W. O. Martin, from May 15 to December 31, and Mr. C. W. Flynn, from June 15 to December 31. The work of all these gentlemen has been performed in a conscien-

tious manner, and their close attention to duty, carrying on their investigations despite many obstacles and frequently undergoing privation and hardship in order to secure valuable information, is to be most highly commended.

Mr. Harry Gustine served as stenographer and office clerk from January 1 to 31, and Mr. J. W. Taylor from May 15 to June 17. Following the resignation of Mr. Taylor, the Executive Committee of the Commission elected Miss L. E. Renneker to succeed him. Miss Renneker has given close attention to her work as stenographer, clerk and accountant, and for her accuracy, interest, and for the immense amount of work done, Miss Renneker is due the thanks of the Commission. Her familiarity with the office work has made possible much field work and investigation by the Entomologist himself which, owing to the amount of correspondence and routine office work, would have been impossible with a less competent clerk in this position.

As Mr. E. S. Hardy tendered his resignation in January, 1906, on account of business interests demanding his attention, the Executive Committee elected Mr. E. C. Cotton, of Columbus, Ohio, to succeed him as Assistant Entomologist. Mr. Cotton entered upon his duties February 2, 1906.

During 1905 the employment of local inspectors was not found necessary.

GENERAL CONSIDERATIONS.

Reference has been made in the foregoing to the direct financial benefit which will accrue to the cotton-growers in the weevil-infested sections if the cultural remedy for the boll weevil is generally adopted. The Commission, by continuing its work along the lines already laid down, can unquestionably bring about the adoption of the cultural methods, and this of itself will repay, in increased cotton production in the boll weevil sections, many times the amount which the Commission will find necessary to expend in this work.

The advent of the boll weevil makes the production of crops other than cotton of much more importance, relatively, than in the past. There is no crop produced which is not subject to more or less damage by insect pests, this damage varying from 5 to 50

per cent, and in some cases amounting to total destruction of a crop. The campaign against injurious insects other than the boll weevil is therefore becoming of much more importance than heretofore. The fruit-growing industries, for example, cannot be successful, one year with another, unless the fruit-growers possess reliable information regarding the methods of controlling the insects which yearly threaten the fruit crop.

It is unnecessary to call attention to the many insect enemies which affect sugar cane, corn, alfalfa, pecans, oranges, garden and truck crops, etc., which annually levy a heavy toll. Many of these insects are practically unknown, so far as their development, habits and natural enemies are concerned, and until they have been carefully studied means cannot be successfully devised for mitigating the damage for which they are responsible.

The experience of other States has shown that in the past the average annual destruction by insects has been equivalent to at least 10 per cent of the agricultural products. The value of Louisiana's agricultural produce, exclusive of live stock, is approximately $111,000,000 per annum. The insect damage in Louisiana is undoubtedly higher than the 10 per cent mentioned, owing to the fact that insects, both sub-tropical and temperate in their distribution, occur here in unusual numbers, and also owing to the fact that several extremely destructive pests have already been introduced into the State from foreign countries.

The damage by insects in the State of Louisiana must exceed ten millions of dollars annually. Space cannot be taken here to present statistics regarding the insect damage done to various crops and products, but it is sufficient to call attention to the fact that an unlimited field is here presented for the State Crop Pest Commission to bring about a saving of thousands of dollars annually to our farmers and planters by furnishing them with reliable information concerning the means by which these enemies may be controlled or destroyed.

The Secretary, therefore, has no recommendation to make, other than that the Commission continue actively the work begun, and by preventing the dissemination of dangerous insect enemies by suitable quarantine measures, by investigating and devising remedies for insect pests and by disseminating information re-

garding remedial steps, continue to reduce the enormous losses being suffered from enemies already with us and to protect the agriculture of the State against other enemies which may in the future threaten the prosperity of our farmers and fruit-growers.

SUPPLEMENTARY REPORT.

Financial Statement.

1904.

	Cr.	Dr.
Receipts from State Treasurer		$10,000 00
By per diem and expenses of Hon. B. W. Marston, Commissioner	$ 256 75	
Per diem and expenses of Hon. L. S. Frierson, Commissioner	243 60	
Expenses of Hon. J. G. Lee, Commissioner	20 30	
Salary, Entomologist and Secretary	200 00	
Salaries, Assistant Entomologists and Inspectors	232 53	
Salary, clerk and stenographer	135 00	
Traveling expenses of Entomologist	292 69	
Traveling expenses of Assistant Entomologists	323 25	
Field experiments	55 94	
Postage	74 69	
Telephone service	5 45	
Express and freight	32 80	
Publications	1,313 24	
Stationery and printing	368 04	
Office expenses	295 12	
Rent	127 50	
Laboratory apparatus and expenses	74 16	
Furniture	76 05	
Rental paid farmers in Sabine Parish on cotton lands	5,072 80	
Contingent and miscellaneous expenses	65 65	
Total expenditures, 1904	$ 9,265 56	
Bills receivable, December 31, 1904	90	
Cash balance on hand December 31, 1904	733 54	
	$10,000 00	$10,000 00

Financial Statement.

1905.

	Cr.	Dr.
Balance on hand January 1, 1905.....		$ 733 54
Receipts from State Treasurer, January 1, 1905, to December 31, 1905.....		15,000 00
By per diem of Hon. B. W. Marston, Commissioner .....$	350 00	
Traveling expenses of Hon. B. W. Marston, Commissioner.....	380 05	
Per diem of Hon. L. S. Frierson,- Commissioner	55 00	
Traveling expenses of Hon. L. S. Frierson, Commissioner	32 60	
Traveling expenses of Prof. W. R. Dodson, Commissioner	12 40	
Salary, Entomologist and Secretary..	214 39	
Salaries, Assistant Entomologists...	2,021 44	
Salary, clerk and stenographer.....	687 02	
Traveling expenses of Entomologist..	369 91	
Traveling expenses of Assistant Entomologists	1,720 94	
Field experiments	675 99	
Postage	190 06	
Telephone service and telegrams.....	112 20	
Books and technical magazines.....	370 99	
Express and freight.....	117 02	
Stationery	89 76	
Publications	264 52	
Printing of regulations, records, blank books, etc.....	238 65	
Office expenses	531 78	
Rent	418 45	
Electric current (lights).....	15 55	
Laboratory apparatus and expenses..	1,010 87	
Furniture	610 07	
Cotton seed for distribution in Sabine Parish	587 84	

Financial Statement, 1905—*(Continued).*

	Cr.	Dr.
Contingent and miscellaneous expenses	$ 112 43	
Total expenditures	$11,189 93	
Cash on hand December 31, 1905	4,071 11	
Bills payable, December 31, 1904	1 50	
Accounts to credit of Commission, December 31, 1905	471 00	
	$15,733 54	$15,733 54

APPENDIX.

Circular No. 3.

"The Remedy for the Boll Weevil."

A Brief Discussion of the Steps Necessary to Produce a Profitable Crop of Cotton in Sections Infested With the Boll Weevil, by Means of the "Cultural Remedy."

Circular No. 4.

"The San Jose Scale."

Its Nature and Habits; How to Detect It and How to Control It.

Circular No. 5.

"The Work of the State Crop Pest Commission With the Boll Weevil."

Circular No. 6.

"A Preliminary Report on the Horseflies of Louisiana, With a Discussion of Remedies and Natural Enemies."

CIRCULAR NO. 3

OF THE

State Crop Pest Commission of Louisiana

The Remedy for the Boll Weevil

A Brief Discussion of the Steps Necessary to Produce a Profitable Crop of Cotton in Sections Infested with the Boll Weevil, by means of the "Cultural Remedy."

BY

WILMON NEWELL

Issued by the State Board of Agriculture and Immigration.

J. G. LEE, - Commissioner

SHREVEPORT, LA.
CASTLE PRINTING COMPANY
1905

State Crop Pest Commission of Louisiana

ORGANIZATION

HON. NEWTON C. BLANCHARD, Governor of Louisiana, Baton Rouge.

HON. J. G. LEE, Commissioner of Agriculture, Baton Rouge.

PROF. W. R. DODSON, Director of the Louisiana Agricultural Experiment Stations, Baton Rouge.

HON. L. S. FRIERSON, - - - - - - Frierson.

HON. B. W. MARSTON, - - - - - - Eastpoint.

WILMON NEWELL, Entomologist of the Louisiana Agricultural Experiment Stations; Secretary and Entomologist of the Commission, Shreveport.

E. S. HARDY,
J. B. GARRETT,
W. O. MARTIN,
C. W. FLYNN.
} Assistant Entomologists and Inspectors, Shreveport.

MISS L. E. RENNEKER, Clerk and Accountant, Shreveport.

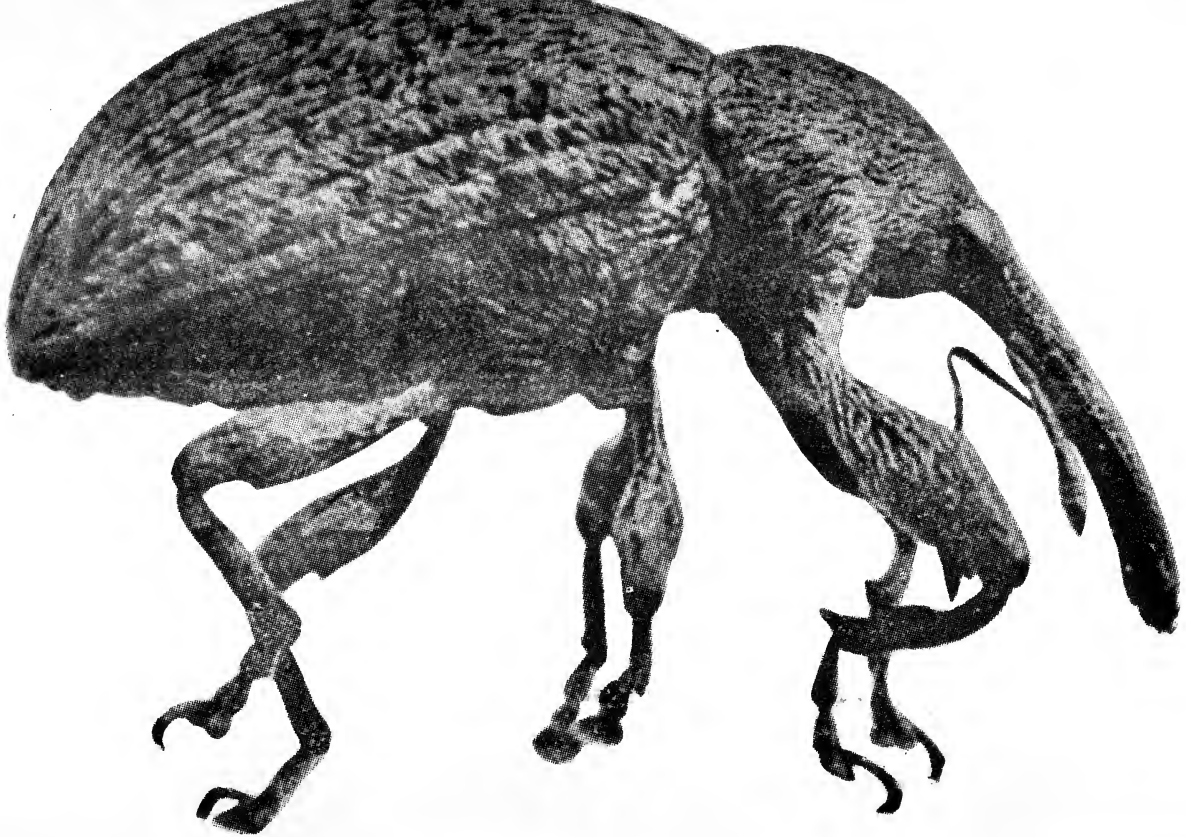

FIG. 1—Mexican cotton boll weevil (*Anthonomus grandis*), greatly enlarged (After a photo by E. D. Sanderson).

State Crop Pest Commission
Of Louisiana.

CIRCULAR No. 3. *NOVEMBER 1905*

The Circulars of the State Crop Pest Commission are sent free of charge to all farmers and fruit growers of Louisiana who make application therefor.

THE REMEDY FOR THE BOLL WEEVIL.

BY WILMON NEWELL.

Although the Crop Pest Commission of Louisiana contemplates publishing a full and complete report upon the investigations made in connection with the boll weevil during the past two seasons, giving the results obtained by extensive and quite conclusive experiments with both Paris green and the cultural measures, it appears advisable to issue at present a brief circular of information regarding the main steps embodied in the cultural remedy.

The compilation and illustration of the larger report referred to, will of necessity be delayed until the season's field work has been completed, which will not be prior to January 1, 1906, and after that date the preparation and distribution of the bulletin will require several weeks of work. It is the desire of the Commission to place accurate information in the hands of all the farmers in the weevil-infested territory at as early a date as possible, especially as the weevil, by its migratory flight eastward, has occupied considerable territory in which it has not heretofore been known, and in which the farmers have had no experience or instruction in the methods that must be employed to successfully produce cotton in spite of this pest.

The majority of progressive farmers plan their season's work several months in advance, and in the boll weevil section, the farmer will find it advisable to have a thorough knowledge of the cultural remedy in order to properly plan his work for the season of 1906. For this reason the present circular is issued, to be followed later by a more complete report.

The territory in Louisiana, occupied by the boll weevil up to December, 1904, is shown by Fig. 2. The territory occupied

by the weevil in the early summer of 1905 is shown by Fig. 3. It will be noticed that the infested territory decreased considerably following the long wet winter, the weevils being apparently completely exterminated in the eastern portion of the

FIG. 2—Area (shaded) in Louisiana, infested by the boll weevil in December, 1904.

territory gained by them in the fall of 1904. It is worthy of note, however, that all of this territory lost by the insects was territory which they did not enter until after about September, 10, 1904, and in which, therefore, they did not have time to breed up to considerable numbers before the arrival of frost. In Western Louisiana, where they had an opportunity to breed through the greater part of the season, many survived the winter successfully. Even should the winter of 1905-1906 be fully as wet and severe as the one of 1904-1905, the weevils may be expected to survive in considerable numbers in a much larger area than they did last winter. The winters cannot be de-

pended upon to solve the boll weevil problem in Louisiana, and there is nothing to indicate that the weevils will not survive the winters in Louisiana in as great numbers as they do in Texas.

In spite of the loss of territory by the boll weevil, during the

FIG. 3—Area in Louisiana infested by the boll weevil in July, 1905.

past winter, they have made a marked gain to the eastward by their migratory flight, which began during August and continued until the early part of November, decreasing in volume and extent with the approach of colder weather. This migratory flight regained for the insect all of the territory which it had lost and a considerable area in addition. The distribution of the weevil in Louisiana, and the territory occupied by it at the present time, is shown by Fig. 4. Although the **net** gain in territory by the insect since December, 1904, has not been nearly so great as was feared, nevertheless this gain includes about four-fifths of the Red River Valley of Louisiana,

one of the richest cotton-producing sections of the South. About one-fifth of the cotton-producing territory of the State is now infested by the boll weevil, but the infestation in at least 30 per cent of this area is at present so light that excessive damage by the boll weevil cannot be anticipated the coming season. In spite of this fact, however, the application of the cultural remedy next year in the territory now but lightly infested is of as much importance as in the heavily-infested territory, in order to reduce the weevil damage that will be threatened in 1907. More particular reference to this will be made below.

FIG. 4—Area in Louisiana infested by the boll weevil in November, 1905.

THE CULTURAL REMEDY.

Ever since the appearance of the boll weevil in Southern Texas in 1892, the efforts of the United States Department of Agriculture and of the officials of the State of Texas have been

directed towards finding a remedy for the insect. Every suggestion that offered any possibility of being developed into a remedial measure has been thoroughly tested, and the life history and the habits of the boll weevil have been thoroughly studied by the best entomologists in America. At the present time more is known regarding this insect than regarding any other of the thousands of insects which occur in this and other countries.

As a result of the exhaustive investigations and experiments carried on by the United States Department of Agriculture, Bureau of Entomology, under the able direction of Dr. L. O. Howard and Prof. W. D. Hunter, the "cultural method" of avoiding the greater part of the boll weevil damage, thereby producing profitable crops of cotton in defiance of the boll weevil, was devised. It is very probable that the cultural methods will, by further experimentation, be developed to greater effectiveness than at present, and the majority of intelligent planters have now come to realize that in the cultural method, or "cultural remedy," lies the only true remedy for the boll weevil. In view of the numerous experiments that have been made, both by entomologists and planters, and in view of the very complete knowledge of the weevil now possessed, there appears no possible chance of any remedy, aside from the cultural remedy, ever being found. Even the "quacks" and "patent" remedy agents, who, a few years ago, sold the farmers thousands of dollars' worth of so-called boll weevil "remedies," have given up hope, and have, for the most part, disappeared.

In the cultural method lies the only real remedy for the boll weevil, and for that reason we prefer to call it by its right name—i.e., the "cultural remedy."

For its successful application the cultural remedy requires: (1) early planting; (2) the use of a quick-maturing variety of cotton; (3) judicious use of fertilizers on soils requiring them; (4) thorough cultivation; (5) destruction of cotton plants in the fall, three to five weeks before the first killing frost, and (6) diminishing the number of favorable hibernating quarters. These measures are referred to more in detail below.

I—Early Planting.

The central idea upon which the cultural remedy is based, is that of producing a crop of cotton before the boll weevil becomes abundant enough to destroy all squares as fast as they

are formed by the cotton plants. As only a small per cent of the weevils entering hibernation in autumn, survive until the following spring, there are not sufficient weevils in the fields in early spring to cause any perceptible damage. Their rate of increase is, however, so great—being in excess of fifty-fold for each successive generation*—that by the middle or latter part of August the weevils have usually become abundant enough to puncture (and hence prevent the development of) every square. The advisability of early planting must therefore be self-evident.

The cotton should be planted just as early as possible, even if some slight risk is taken of a late frost necessitating a second planting. The advantage to be gained from an extra early planting is sufficient to far more than compensate for the work and cost of an occasional second planting as the result of an unexpected late frost.

Lands which are not subject to severe washing should, whenever possible, be plowed with the turning plow in the fall so they will be in the best possible condition for early spring planting and for rapid germination of the seed. Aside from the advantage of this fall plowing with relation to the boll weevil, it also serves to destroy large numbers of the boll worm (an insect entirely separate and distinct from the boll weevil), which in most years is responsible for a large amount of damage to the Louisiana cotton crop.

II—Early Varieties of Cotton.

For early planting in boll weevil sections, "King" cotton has been found most satisfactory. "Rowden" is preferred by many farmers on account of the staple being more in demand than that of "King" and Rowden, during the present season has been reported as giving very satisfactory results. "Shine's" is also a good variety for use where an early crop is desired.

Prof. W. D. Hunter, of the Bureau of Entomology, reports that the "Triumph" variety, originated by Mr. A. D. Mebane, of Lockhart, Texas, has yielded on the black lands of Texas, with boll weevils present, to exceed 1100 pounds of seed cotton per acre. It is not unlikely that this variety will be found well-adapted to some of the similar Louisiana soils. "Parker" cotton, in the experiments conducted by the Bureau of Entomo-

*Hunter & Hinds, Bulletin No. 51, Bureau of Entomology, p. 97.

logy, United States Department of Agriculture, has also given good yields in the boll weevil infested sections of Texas, but has not been found quite as productive as King.

Regardless of which early variety is decided upon by the farmer, he should exercise extreme care in purchasing seed, in order to guard against mixed seed, or seed which is sold under a misrepresentation. Owing to the large demand for "King" during the past two seasons, several unscrupulous parties in the eastern part of the Cotton Belt have sold ordinary native seed at high prices, representing it to be the pure King seed.

If seed is purchased through well-known and reputable seed houses there will be little difficulty from this source. Regardless of where the seed is purchased, the buyer should insist upon receiving with it a written guarantee of its purity.

The Commission expects to compile, during the coming winter, a list of Louisiana farmers who have comparatively pure King or Rowden seed for sale, this list to be furnished to those who apply for it.

The Commission will not advertise or guarantee anyone's seed, but no planter will be included in this list until the Commission is satisfied regarding the purity of the seed he has to sell, the conditions under which it is grown, etc. Farmers wishing to receive this list, as well as those who have seed of either of these varieties for sale, should communicate with the Crop Pest Commission at Shreveport.

III—Use of Fertilizers.

The use of fertilizers in connection with the cotton crop seems not to be universally practiced in Louisiana. Upon the upland soils and upon light sandy soils, the use of a "complete" commercial fertilizer has been found profitable and has been found to materially hasten the development and maturity of the crop. In cultural experiments carried on in Sabine Parish this season by the Crop Pest Commission, the application of 200 pounds per acre of "8-2-2" commercial fertilizer prior to planting gave excellent results, in spite of the fact that severe washing rains followed for several days after the fertilizer was applied, and it was thought that most of it had been leached out.

On botton lands, the need for fertilizer is not so evident, but even here the use of a fertilizer containing a considerable amount of available phosphoric acid is found to hasten maturi-

ty to a considerable extent, and in sections badly infested by the boll weevil, nothing should be neglected which will be conducive to early maturing of the crop. On most of the alluvial lands, nitrogenous fertilizers are not needed, and indeed are for the most part undesirable, as nitrogen tends to make a luxuriant growth of the plant at the expense of early fruitage. Luxuriant plants furnishing an abundance of shade and moisture are conducive to the rapid development and increase of the boll weevils.

IV—Thorough Cultivation.

The effect of thorough cultivation is to keep the plants growing continuously and to increase the formation of bolls and hasten their maturity. One chopping and three cultivations cannot be considered "thorough" cultivation. The ideal cultivation is one which results in a "dust mulch" being maintained in the field throughout the spring and early summer. As conditions vary to a great extent in different sections of the state and upon different soils and plantations, a hard and fast rule regarding what constitutes a "thorough cultivation" cannot be laid down. In general, however three choppings and about five cultivations will result in rapid development of the plants and in hastened maturity.

Upon many farms and plantations in Louisiana the cultivation of the cotton crop heretofore has been virtually as good as it could be under any conditions, and very little if any improvement in the care of the crops could be made. Upon the majority of farms, however, thorough cultivation has not been practiced, and especially is this true where the tenant system has been employed, and where plantation managers themselves have attempted to cultivate the largest possible acreage with the labor at their command. Upon such plantations there must be a reduction of the cotton acreage in proportion to the labor employed, to the point where the crop can be thoroughly cultivated and cared for. Hard and fast work to make a "quick" crop must be the motto in heavily-infested boll weevil sections.

V—Fall Destruction of Cotton Plants.

This is by far the most important step in the cultural remedy. The steps enumerated above—early planting, use of quick-maturing varieties, judicious use of fertilizers and thorough cultivation—all have as their object the production of a crop

before the boll weevils become abundant. Of actual means by which the boll weevils themselves may be destroyed, we have but two that are practical—the fall destruction of the cotton plants and decreasing the number of favorable hibernating quarters. Of these two, the latter is of only small importance compared to the destruction of the cotton plants.

As was stated on a previous page, but few weevils succeed in surviving the winter and even in the most heavily infested sections it is difficult to find weevils in the cotton fields when the cotton first appears above ground in the spring. As a result of careful laboratory studies, combined with field observations, Messrs. Hunter and Hinds have found that the progeny of one pair of hibernated weevils amounts, at the end of the first generation, about June 29th, to 100, and the progeny of these weevils, by the middle of August, amounts to 5,000. The third generation, becoming adult about the third week in September, in turn produces a total of 250,000 as the progeny of the 5,000, provided a sufficient number of squares and young bolls are present in the field*.

In reality a state of "gross infestation" is usually reached about the middle or latter part of August, every square at that time being punctured, either for egg deposition or for feeding. From that time on the increase in the number of weevils is limited only by the available supply of green squares, forms and young bolls. Could the cotton plants produce squares fast enough, the progeny of a single pair of hibernating weevils, by December 1st, would be at least 15,000,000, by the most conservative calculation.

It will readily be seen therefore, that with a supply of food available late in the fall, the last generation of the season will produce far more weevils than all of the preceding generations of the season put together. By the total destruction of the cotton plants three to five weeks before the first hard killing frost (which is, roughly speaking, the time when weevils seek hibernating quarters), the development of this last brood of weevils is entirely prevented. By this step the farmer can reduce by more than one-half, the number of weevils that would ordinarily be present to go into hibernating quarters early in December. Of equally as great importance is the fact that this destruction of the cotton plants forces all weevils which have

*Bulletin No. 51, Bureau of Entomology, p. 97.

reached the adult stage prior to the time of this destruction to remain without food until time for them to enter hibernation. In the average season, only a small per cent could possibly survive as long as five weeks without food. On October 16th, 1905, a supply of adult weevils was collected in a cotton field in DeSoto Parish, all of them being taken from squares upon which they were feeding. These weevils were furnished with water daily, but were not given any squares or bolls upon which to feed. By October 28th, 50 per cent of them were dead, and by November 6th, 84 per cent were dead. It is very doubtful if any of them will survive until December 1st, and, judging from the actions of the weevils in the fields at present, it does not seem likely that any considerable number will seek hibernating quarters before the latter date.

The early fall destruction of the cotton plants accomplishes a double purpose: the prevention of the development of the usual late autumn brood of weevils, and the death by starvation of at least 75 per cent of the weevils that are present in the fields at the time the plants are destroyed by the planter.

Practically the only objection to this fall destruction of the cotton plants which has been advanced, is that the stalks cannot be destroyed early in autumn without sacrificing a considerable part of the crop not yet gathered. Under the present system in vogue on most of the Louisiana farms, the objection is a valid one, BUT THE SYSTEM MUST BE CHANGED to that of planting an early variety of cotton, planting it early and giving it proper care and cultivation. If this is done, the bulk of the crop will be open and ready for picking before the time arrives for the destruction of the cotton plants. The mere fact that some farmers do not have the labor at hand to pick out the cotton within a reasonable time after it opens, is by no means the fault of the remedy. The early fall destruction of the cotton plants is an absolute requisite to successful and profitable cotton production with the weevil present, and the farmer in the weevil-infested section who cannot adapt his labor conditions and farming methods to meet this requirement will save money by not attempting to grow cotton.

In most of the Red River Valley, and in the eastern portion of the territory which has not been entered by the boll weevil until the present season, the weevil damage is not likely to be excessive in 1906, regardless of what farming methods may be

followed. However, to prevent a severe loss from the weevil in 1907, it will be necessary for the farmers in this territory to destroy their cotton plants in the fall of 1906. In order to have their cotton picked and out of the way before the time arrives for this destruction of stalks next fall, they must adopt the cultural remedy and methods next spring.

The fact should not be overlooked, that in a boll weevil-infested section, no "top crop" is ever produced. The top crop must be sacrificed, either to the weevil, or to the "fall destruction" of cotton plants. So long as the latter is a direct and effective step in reducing the weevils' numbers, the sacrifice is turned to good account. It is also evident that the value of the so-called "top crop" has been greatly magnified in most sections, and its loss, in reality, does not greatly affect the total production.

Upon small farms, where sufficient stock is at hand, cattle can be turned into the cotton fields, and by close grazing they will entirely destroy the weevils' food supply, making the actual destruction by the planter unnecessary. This plan will not prove entirely satisfactory, however, unless sufficient cattle are at hand to keep destroyed all squares and leaves as fast as they are formed upon the plant. It is perhaps unnecessary to utter a word of caution against admitting cattle to fields where, for any reason, Paris green has recently been applied.

In fields where the cotton caterpillar entirely defoliates the cotton by the middle of October (in average seasons), actual destruction of the stalks is also unnecessary, as the total destruction of all foliage and squares disposes of the great bulk of the weevils' food supply and breeding places. The work of the caterpillars should not be depended upon except where the defoliation is complete. Where the caterpillar has entirely defoliated the major part of a field, leaving an occasional small area still green, this latter should be destroyed by the planter.

We do not expect the reader to accept the foregoing too liberally, and refrain from applying poison for the caterpillar when the latter appears early in the season. Regardless of the good that the caterpillar may do in the fight against the weevil late in the season, the caterpillar itself must be kept in control during early and mid-summer.

Upon bottom lands, where the growth of the cotton plant is luxuriant, a few caterpillars through the cotton fields in the

latter part of the summer are most desirable, as by their "ragging" of the foliage, the sunlight is permitted to reach the unopened bolls and hasten their development and opening.

On the upland farms, the destruction of stalks can best be accomplished by plowing them up, raking them together in windrows and burning them. On lands that do not wash badly, a thorough plowing with turning plow should follow, not so much because of its direct effect in destroying weevils, but because it places the ground in much better condition for early planting the following spring.

On the bottom lands, the stalks can often be destroyed more economically by cutting them down with the triangular stalk-cutter, afterwards raking them into windrows and burning them. This should be followed by plowing out the "stumps" of the cotton plants, as these latter, especially in the moist seasons, produce sprouts which furnish plenty of food for the weevils.

VI—Destruction of Favorable Hibernating Places.

In Louisiana the situations in which the weevils may successfully hibernate are so numerous that any systematic attempt to burn them over or destroy them effectually is entirely out of the question. In the cotton fields themselves, however, ditch banks should be burned over during the winter in those localities where the removal of the vegetation will not result in severe washing. Such things as old and useless "worm" fences and weed-grown lots around tenant houses should be cleaned up, burned, or in some other suitable manner disposed of. Cane or sorghum fields which are adjacent to cotton fields should be either plowed well or burned over during the late fall or during the winter.

Of most importance in this connection is the removal of the "cotton seed houses," or loosely constructed sheds, in which many farmers store their planting seed during the winter, from the cotton fields to more isolated positions. These loose open buildings, with the seed contained in them, offer dry and warm shelter for the weevils through the entire winter, and in a number of instances they have made their first appearance in spring upon the cotton grown adjacent to these buildings. Preferable to the removal of the houses from the cotton fields, would be the plan of storing the following year's supply of seed in a building that is made weevil-proof by the use of wire cloth. A cotton seed house and the cotton for which it furnished boll weevils in the spring of 1905 is shown in Fig. 5.

FIG. 5—Favorable hibernating quarters for the boll weevil. The building on the left contained cotton seed during the winter of 1904-05, and the first weevils to appear upon the plantation, in the spring of 1905, appeared in the young cotton to the right, having successfully survived the winter in the dry, protected cotton seed (After a photo by Dr. W E. Hinds).

RULES AND REGULATIONS OF THE STATE CROP PEST COMMISSION

Governing the Shipment of Materials Likely to Disseminate the Cotton Boll Weevil.

For convenient reference, we give below such regulations of the State Crop Pest Commission as govern the movement and transportation of cotton seed and other products and materials likely to introduce the boll weevil into new territory. A full copy of the Regulations of the Commission may be had free of charge upon application to the Secretary of the Commission:*

SECTION I.

Be it declared, ordained and ordered that the following insects are hereby declared to be dangerous crop and fruit pests:

(a) The Mexican boll weevil (*Anthonomus grandis.*)

(b) The San Jose scale (*Aspidiotus perniciosus*); provided, however, that this Commission may, from time to time, declare other crop and fruit pests and diseases to be dangerous.

SECTION II.

Be it further ordained and ordered that in order to prevent the introduction of the Mexican boll weevil into the uninfested part of the State of Louisiana, from the State of Texas and from the infested portion of Louisiana where the boll weevil is now known to exist, a quarantine is hereby declared to exist against the State of Texas and against the following Parishes of Louisiana, to-wit: Bossier, Caddo, Calcasieu, Cameron, DeSoto, Grant, Natchitoches, Rapides, Red River, Sabine, Vernon, and Winn.

(a) That no cotton seed, seed cotton, cotton seed hulls(except such cotton seed hulls as are packed, shipped and handled in a manner approved by this Commission, when formal permit for their shipment has been issued by this Commission, such permit to accompany shipment when consigned to any point in the non-infested portion of Louisiana), or cotton-seed sacks or seed-cotton sacks shall be shipped into the uninfested portion of Louisiana, from the State of Texas or from the infested parishes of Louisiana, as above enumerated.

(b) That the quarantine hereby declared may, from time to time, as the necessity may arise, be extended to include counties in any State or Territory, or parishes in the State of Louisiana, or elsewhere.

All railroads, steamboats, express companies and other common carriers entering the State of Louisiana, from the State of Texas or from

*The Rules and Regulations of the Crop Pest Commission are enacted, and amended from time to time as occasion requires, in accordance with Act No. 6 of the Extra Session of the Louisiana Legislature, Approved December 15, 1903, and said Rules and Regulations have the force of law. Violation of any Rule, Regulation or Order of the Crop Pest Commission is punishable by fine or imprisonment.

the infested parishes of this State, are especially enjoined to comply with the requirements of this order and of the laws of the State of Louisiana governing same.

SECTION III.

Be it further declared, ordained and ordered that no person, firm or corporation except a duly authorized state or federal entomologist shall bring into or have in his possession, in the uninfested portion of the State of Louisiana, for any purpose whatever, any living Mexican boll weevil or cotton boll, square, plant or seed containing the Mexican boll weevil, whether adult or in the pupal, larval or egg state; and any such person, firm or corporation violating this provision of the Act of the Legislature shall on conviction, as prescribed by Section 4 of Act No. 6 of the Extra Session of the Legislature, Approved December 15, 1903, be fined not less than twenty-five dollars, nor more than one thousand dollars for each offense, or imprisoned for not less than ten days, nor more than six months.

CIRCULAR NO. 4

OF THE

State Crop Pest Commission

OF

LOUISIANA.

THE SAN JOSE SCALE.

Its Nature and Habits; How to Detect It and How to Control It.

BY

WILMON NEWELL.

ISSUED BY THE

STATE BOARD OF AGRICULTURE AND IMMIGRATION.

J. G. LEE, Commissioner.

BATON ROUGE:
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State Crop Pest Commission of Louisiana.

ORGANIZATION.

HON. NEWTON C. BLANCHARD, Governor of Louisiana, Baton Rouge.

HON. J. G. LEE, Commissioner of Agriculture, Baton Rouge.

PROF. W. R. DODSON, Director of Louisiana Agricultural Experiment Stations, Baton Rouge

HON. L. S. FRIERSON, Frierson.

HON. B. W. MARSTON, Eastpoint.

WILMON. NEWELL, Entomologist of Louisiana Agricultural Experiment Stations; Secretary and Entomologist of the Commission, Shreveport.

E. S. HARDY, J. B. GARRETT, W. O. MARTIN, C. W. FLYNN, Assistant Entomologists and Inspectors, Shreveport.

MISS L. E. RENNEKER, Clerk and Accountant, Shreveport.

State Crop Pest Commission
Of Louisiana.

CIRCULAR No. 4. December, 1905.

The Circulars of the State Crop Pest Commission are sent free of charge to all farmers and fruit growers of Louisiana who make application therefor.

THE SAN JOSE SCALE, A DESTRUCTIVE INSECT ENEMY OF DECIDUOUS FRUIT TREES.

Its Nature and Habits, How to Detect It and How to Control It.

BY WILMON NEWELL.

The advent of the boll weevil in Louisiana has made it expedient for the general farmer to give consideration to the production of crops other than cotton. While the damage from the boll weevil has not thus far been seriously felt in more than two or three very limited areas in Louisiana, still it is destined within a few years to render impossible profitable cotton culture *upon as large a scale* as formerly, and at the present time it does not appear possible to permanently prevent this insect from crossing the entire State. While the proper administration of sensible and reasonable quarantine measures will in all probability prevent the weevil from being transported long distances in shipments of cotton seed and hulls, thereby causing isolated infestations to appear many miles ahead of the line of gradually advancing infestation, the migratory habits of the weevil will render futile any attempt to permanently confine the area of infestation to its present limits. In the light of present knowledge, ultimate boll weevil infestation of the entire cotton-producing area of Louisiana appears inevitable.

The farmer who shall have successfully adapted himself and his methods to a diversified system of agriculture by the time the

boll weevil infests his plantation severely, will feel the ravages of this insect but little. In this diversification, the production of fruit should, and doubtless will, play a most important part. The climate and soils of Northern and Western Louisiana are eminently adapted to the production, not only of small fruits, but also of the more important commercial fruits, such as peaches, pears, etc. The red clay soils of the upland sections of Louisiana differ in no essential from the red clay soils of Tennessee and Georgia, which have long since become famous for their commercial peach orchards.

A commercial peach orchard, intelligently and properly cared for, has repeatedly proven to be far more profitable than the best crop of cotton that can be grown, even when the latter brings from twelve to fifteen cents per pound. As yet the fruit-growing possibilities of Louisiana have not been even fairly tested, but many of those who have already undertaken commercial peach growing in North Louisiana have demonstrated that the conditions there prevailing are as near the ideal as could be obtained anywhere.

Doubtless the most serious obstacle to successful fruit growing, by both the commercial grower and the farmer, is the insect pest known as the San Jose (pronounced San Ho-zay) scale, which has, unfortunately, already obtained such a foothold in many parts of Louisiana as to make its complete eradication and extermination impossible. Many farmers have undertaken the production of an orchard and have started out under apparently favorable conditions, with trees that grew vigorously for the first year or so, only to find that when the trees reached bearing age they began to die rapidly and in the course of three or four years the orchard was ruined completely. It is safe to say that not one farmer or fruit grower out of fifty has, under such circumstances, recognized the minute insect responsible for the destruction of his orchard. During the past few months the writer has met dozens of intelligent, up-to-date farmers and fruit growers who have had this experience, and who were in entire ignorance of the reason for their failures. On making an examination of the few straggling trees that remained of the former "orchard," the writer has invariably found the San Jose scale in

abundance. From observations made during the past season the writer is convinced that the San Jose scale, more than all other agencies combined, has been responsible for the failure of the peach crop to become of great importance, for if properly cared for, this should be one of the most important crops, from a financial standpoint, in North Louisiana.

The occurrence of this pest within the State may be ascribed principally to the fact that Louisiana has not until very recently had in effect a quarantine system against this and other fruit tree pests. All of the leading fruit-growing States of the Union, and, in fact, a majority of all the States, have for several years had in force quarantine laws which made it practically impossible for nurserymen with scale-infested trees, to market their stock in those States. The natural result has been that those States wherein quarantine laws did not exist, or were not enforced, have been the "dumping grounds" for nurseries whose stock was infested with the pest and therefore barred from the States that were properly protected.

The fruit-tree "peddlers," many of whom make a practice of purchasing poor or worthless nursery stock at a low price and peddling it out to farmers who are ignorant of its true condition have also doubtless been responsible for much of the dissemination of this pest in Louisiana.

When the San Jose scale first appeared in the Eastern States, the fruit growers were inclined to give up all hope, and many fears were expressed that the advent of this little insect would prove the destruction of the entire deciduous fruit-growing industry of the country. However, after a number of years of pains-taking experiments, carried on by entomologists and Experiment Stations over the entire country, assisted by the larger commercial fruit growers, an effective remedy for this pest has been devised, and the progressive, intelligent fruit grower need have no fear of this pest destroying his orchards, or even reducing their productiveness or longevity if he will combat it intelligently.

As the State Crop Pest Commission was established to deal not only with the cotton boll weevil, but with other serious crop and fruit pests as well, and as the San Jose scale is already a

serious obstacle to successful fruit growing, it seems but proper that the Commission should at this time publish a description of the San Jose scale, together with the remedies that should be

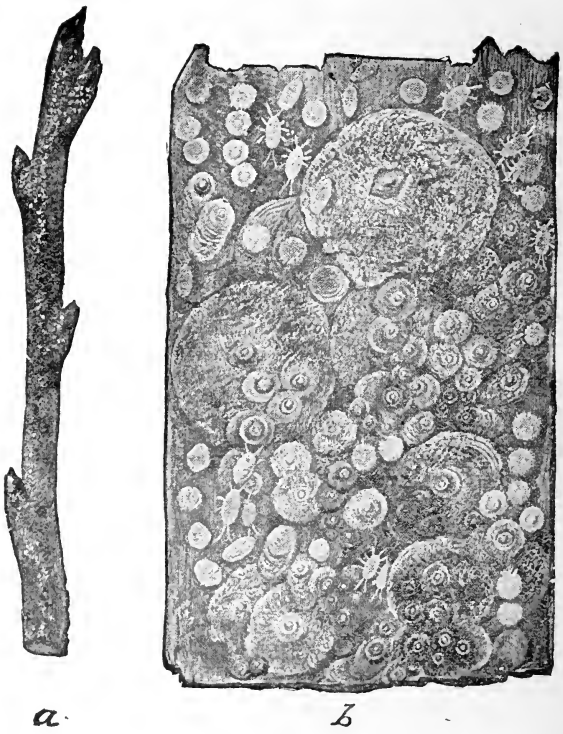


FIG. 1.—Appearance of San Jose scale upon the bark of a fruit tree: a, infested twig, natural size: b, bark as it appears under hand lens, showing scale in various stages of development, and young larvae. (After Howard & Marlatt, Bul. No. 3, n. ser., Div. of Entomology, U. S. Dept. of Agriculture).

applied in infested grounds and orchards. The descriptions and illustrations of the insect, it is hoped, will be of assistance to fruit growers in recognizing the pest in their orchards, while the remedies recommended we know from experience and observation to be fully efficient. The present short bulletin does not present any facts new to entomologists or Experiment Station workers, but is made up for the most part of compilations and from the experiments and observations made by the writer in other States.

History of the San Jose Scale.

The San Jose scale was first described in 1880, by Prof. J. H. Comstock, then Entomologist of the U. S. Dept. of Agriculture, from specimens taken in Santa Clara County, California. Prof. Comstock at that time gave it the very appropriate name of *Aspidiotus perniciosus,* meaning the pernicious scale, as it has since proved itself to be one of the most pernicious pests with which the fruit grower has ever had to deal.

Owing to its abundance in the San Jose Valley of California the common name of "San Jose scale" came to be applied to it.

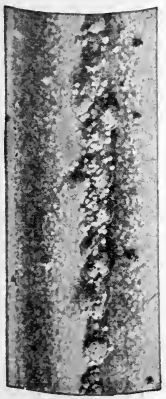


FIG. 2.—San Jose scale on peach twig, twice natural size (After Britton, Bul. 151, Conn. Exp. Station).

Although not described until 1880, the insect had, as early as 1873, become a serious pest in the San Jose Valley.* How it obtained a foothold in California, and the country from which it had been imported, remained for many years in doubt. The finding, in later years, of San Jose scale upon trees imported from Japan, gave rise to the opinion that that country was its native home. Not until 1901-02 was the original home of the insect known with certainty. During those years Prof. C. L. Marlatt of the U. S. Dept. of Agriculture, made a special trip of investigation through Japan and China, with the result that he definitely located the native home of the San Jose scale in that portion of China lying to the north and west of Pekin.** While the San Jose scale continued to encroach upon new territory in California, it was apparently several years before it entered the country east of the Rocky Mountains. The first discovery of the pest in the East was at Charlottesville, Va., in 1893, and subsequent investigations showed beyond a reasonable doubt that it had reached Charlottesville from a nursery in New Jersey. The discovery of infestations in various parts of the country, all of them traceable directly or indirectly to one or the other of two New Jersey nurseries, started an investigation which revealed the fact that the

*Bul. No. 3, n. ser., Division of Entomology, p. 12.
**Yearbook, U. S. Dept. of Agriculture, 1902, p. 166.

scale had been sent to New Jersey in 1886 or 1887 with a shipment of Kelsey plums from the San Jose locality in California.* From their infestation in 1886 or 1887, until the agitation of 1893 and '94, the two New Jersey nurseries mentioned had been steadily shipping nursery stock to various parts of the United States, and with many of the shipments the scale went also. The result was that many nurseries, in a number of different States, became infested, and from these as new centers of infestation, the spread of the insect to orchards was rapid. At the present time nearly every fruit-growing section of any importance is more or less infested by this pest, and a careful study of almost any outbreak makes it possible to trace the insect back, indirectly, to the 1886 (or 1887?) shipment from California to New Jersey.

In Louisiana, the pest is known to occur in over a dozen localities, some of them widely separated, and when a careful survey and inspection of the various orchard sections of the State has been made, no doubt many more localities will be added to the list.

What the San Jose Scale Is.

The San Jose scale is a very small insect belonging to the order known as Hemiptera, or true bugs. While not by any means microscopic in size, the individual insects are sufficiently small to escape the notice of persons not accustomed to looking for scale-insects.

The females, during their entire existence (with the exception of a few hours following birth), and the males from the larval stage to maturity, are protected beneath a scale-like covering consisting in part of secretions from the body of the insect, and in part of shed or molted skins cast off by the insect at different periods in its development. The San Jose scale is a sucking insect and feeds by inserting its long, thread-like beak through the bark into the sapwood of the plant upon which it is located.

The adult female scale is, roughly speaking, about the size of a pin-head and is of a dark grayish color. The scale is nearly round and has near its center a pronounced "nipple" or eleva-

*Bul. No. 3, n. series, Div. of Entomology, p. 15.

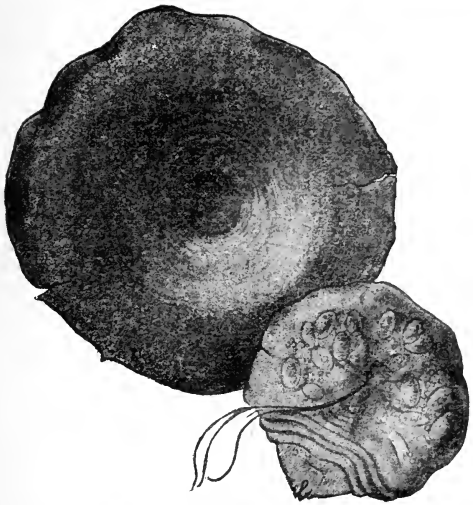


FIG. 3.—Adult female scale turned over, exposing legless and wingless insect.

FIG. 4.—Half-grown female scale.

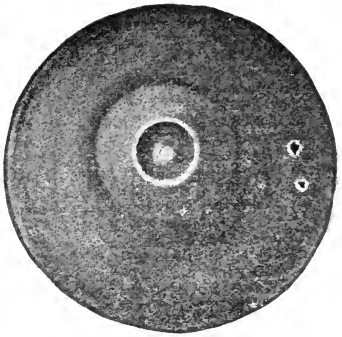
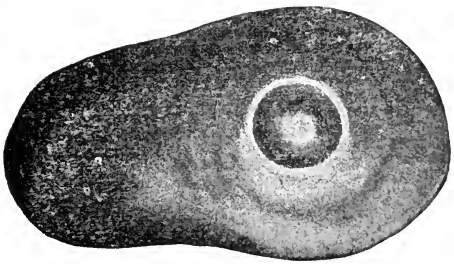


FIG. 5.—Full-grown female scale.



Full-grown male scale.

All much enlarged. (After Alwood, Va., Crop Pest Commission Bulletin No. 45.)

tion, which is surrounded by a fine groove or depression. This nipple-like prominence in the center, together with the ring surrounding it, is quite characteristic of this species and enables one familiar with the pest to recognize it readily in the majority of cases.

If the scale be gently lifted with a knife-point or a pin, a yellowish soft-bodied insect, devoid of both legs and wings, will

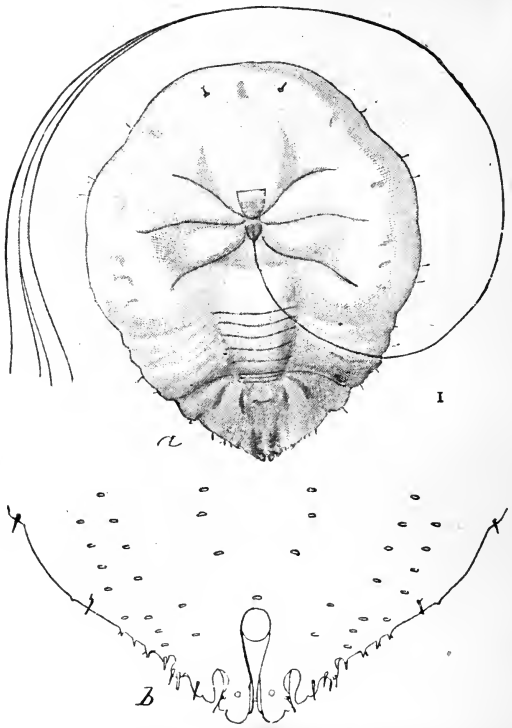


FIG. 7.—Adult female, before development of eggs: a, ventral view, showing long sucking mouth parts: b, posterior margin of anal segment as seen under microscope—greatly enlarged. (After Howard and Marlatt, Bul. No. 3, n. ser., Div. of Entomology, U. S. Dept. of Agriculture.)

be found beneath it. This is the insect itself, the creature which really does the damage. The male scale, while rather closely resembling that of the female, is somewhat smaller and is more elongated.

When the scales occur abundantly upon a twig or limb, the latter has the appearance of having been dusted over with ashes.

A grayish, scurfy appearance of a peach, plum or apple tree should at once excite suspicion. In the case of badly infested trees the scales frequently occur in such great numbers upon the medium-sized limbs that the bark itself is invisible. When an infestation reaches this stage the tree is commonly referred to as "incrusted." During summer the immature stages of the insect are found along with the adult scales, and at this time also the larvae, minute yellow lice, may be found crawling about in abundance over the twigs and limbs. The half-grown female scales are usually almost jet-black in color and are quite different from the partially-matured scales of closely related species.

If the finger-nail, or a knife-blade, be rubbed over a badly infested limb upon which the insects are alive, their bodies will be crushed and the body fluids exuding will not only be visible to the naked eye but will give a smooth, greasy appearance and feeling to the portion rubbed.

Another feature, while by no means characteristic of this scale, which is of considerable assistance in identification, is the reddish cast given to the cambium (sapwood) of the affected twigs and limbs. Where isolated insects occur, the scale, especially upon peach and plum, is surrounded by a reddish area, and if the bark be trimmed from a thoroughly-infested limb the wood just below the bark will be found mottled with red blotches and spots.

While the San Jose scale rarely gets upon the fruit of peach trees, the downy covering of the peach being objectionable to the young lice, the insects do often occur in abundance upon the fruit of plum, apple and pear trees. On fruit the red discoloration is very evident, and we have seen many apples and pears that were so thickly infested that they had become deformed and knotty. In infested peach orchards, the young lice crawl onto the peach leaves in great numbers and establish themselves there, either on the upper or lower surface, usually right next to the mid-rib of the leaf. Red spots quickly follow the attack of the scale upon the peach leaf, and a sprinkling of red spots over the leaves often indicates the presence of the pest even when the infestation upon the limbs and trunk is not sufficient to attract casual attention. In our Southern climate, peach trees attacked

by this insect rarely survive to exceed three or four years and their productive capacity, if they are allowed to remain untreated, is often seriously impaired by the second season of infestation.

The San Jose scale is known to occur upon a great variety of trees and plants. Mrs. H. T. Fernald, in her "Catalogue of Coccidae"* gives a list of sixty-five different plants upon which this insect has been found. Upon the majority its occurrence is only occasional, and it cannot be considered a serious pest to more than a few of them. In the South, severe infestations may be

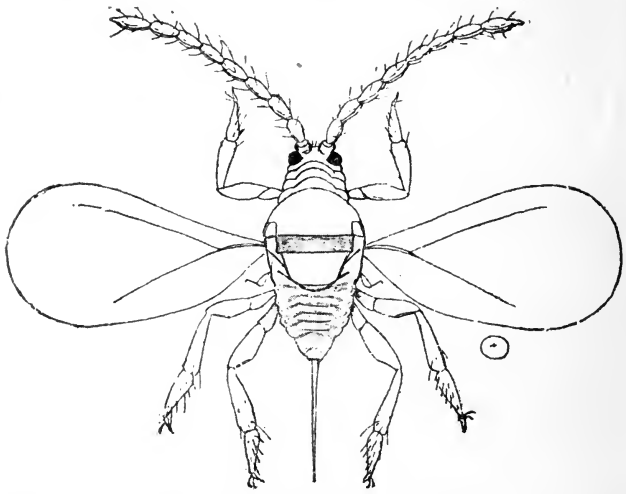


FIG. 8.—Adult male San Jose scale—much enlarged. (After Howard and Marlatt, Bul. No. 3, n. ser., Div. of Entomology, U. S. Dept. of Agriculture.)

looked for upon all varieties of apples, plums, and peaches as well as upon cottonwood, Carolina poplar, Bois D'Arc and the hardy orange (*Citrus trifoliata*). While it is frequently a most serious pest of pear trees in the North, it apparently does not thrive as well upon the pear in the South, although pear trees are occasionally found that have their growth and productive capacity severely impaired by the attacks of the scale. Carolina poplar trees often become very heavily infested, but owing to the vigorous growth of this tree it usually outgrows, in a sense, the attacks of the scale.

* Bulletin 88, Hatch Exp. Station of Mass.

While the San Jose scale cannot be considered as a serious pest of pecan, walnut and other fruit and forest trees, still it must be remembered that such plants, when carrying the scale, may serve as sources of infestation for peach or other orchards. Even though the pest may breed for several generations upon a nut or forest tree, barely maintaining its existence, when spread or transferred from this unfavorable host plant to a favorable one, such as a peach or plum tree, it again breeds as rapidly as ever and becomes fully as destructive as if it had not been forced to subsist for one or more generations under adverse conditions.

Scale Insects Often Mistaken for the San Jose.

The finding of scale insects in an orchard is not of itself proof that the orchard is infested with San Jose scale, for there are a number of other insects, native to Louisiana, that closely resemble it. Among these may be mentioned the Cherry scale, Putnam's scale, Gloomy scale and the Obscure scale. Unlike the San Jose scale these native species are preyed upon to a very considerable extent by ladybugs and other predacious insects which tend to hold them in check. Their rate of increase is not nearly so great as that of the San Jose and hence they are not nearly so injurious.

The Cherry scale* can be found in almost any peach orchard but usually in only limited numbers. While of nearly the same size as the San Jose scale, it is more flattened and has the exuviae (composing the central elevation of the scale itself) of an orange red color. As a usual thing the individual scales of this species are widely scattered over a tree and are parasitized to a marked extent. In only one case have we seen this species abundant enough to cause appreciable injury. Owing to the general occurrence of the Cherry scale, cases are often found where both this scale and San Jose occur together upon the same tree. While the two species have characters by which they are readily separated when a microscopical examination is made, they are frequently difficult to distinguish in the field, and in many cases cannot be distinguished except by one thoroughly familiar with scale-insects.

Aspidiotus forbesi.

Putnam's scale(*a*) is frequently found in Louisiana and while it seems to prefer shade or ornamental trees (such as maple, cottonwood, etc.) it is occasionally found on orchard trees. It is not usually as heavily parasitized as the cherry-scale and is therefore a more dangerous pest. In destructiveness it does not approach the San Jose scale.

The Gloomy scale (*b*) is very cosmopolitan in habit and affects a great variety of trees, being however, but rarely found in orchards. On streets and private grounds in Shreveport we have found it in abundance, indicating that the conditions in Northwestern Louisiana are decidedly favorable for its rapid increase.

The Obscure scale(*c*) is for the most part found upon water oak(*d*) and is a comparatively large, dark-colored, flattened scale, very unlike the San Jose, but is nevertheless often mistaken for that species.

When scale insects are found, especially upon fruit or ornamental trees, they should be sent to the Crop Pest Commission for identification. The writer will take pleasure at all times in advising fruit growers and farmers regarding the identity of scale-insects found in their orchards and gardens.

It is not within the province of this paper to discuss even briefly the scale-insects of the State, nor even the injurious species, of which there are many. A number of these species will be treated of at a later date in a paper contemplated by the writer and one of his assistants.

The remedies recommended herein for the San Jose scale are fully efficient against the other species mentioned above when they occur upon deciduous trees. The sprays mentioned on subsequent pages cannot, however, be used upon citrus trees or upon evergreens.

Development and Life History.

Unlike the majority of our native scale-insects, the female San Jose scale does not deposit eggs, but is viviparous. In other words, the young are born active, the eggs hatching within the

(*a*) *Aspidiotus ancylus.*
(*b*) *Aspidiotus tenebricosus.*
(*c*) *Aspidiotus obscurus.*
(*d*) *Querous aquatica.*

body of the mother instead of developing after the deposition of the eggs as is the case with most insects. The young when born are minute yellow creatures scarcely visible to the naked eye, and are possessed of six legs, two antennae or feelers, and a well-developed beak. They are active as soon as born and for the first few hours of their existence devote themselves to a diligent search for a location that is to their liking.

At any time during the summer these minute crawling "lice" may be seen running about on the leaves, fruit and bark of badly infested trees. Within a few hours—usually from 12 to 36—after birth, the young louse finds a place where the bark is not too thick, inserts its beak through the bark into the sap-wood beneath and commences feeding. Within a short time, waxy filaments, secretions from the dorsal portion of the body, make their appearance and soon form a grayish-white mat over the insect. This is the beginning of the scale covering, and as the insect develops, the covering is added to from time to time by more secretions, and by the skins which are shed by the insect as it grows. If the individual be a female it remains in this position during its entire life, and shortly after locating and commencing the formation of a scale, loses feet, eyes and antennae, becoming entirely incapable of moving about. The skins which are thrown off from time to time as the insect grows are added to the scale-covering until at last the female reaches maturity, by which time the scale has become dark-colored, its particular shade being determined to a very large extent by the color of the bark upon which it happens to be located.

The development of the male is similar, the legs being lost soon after the beginning of scale formation. Instead, however, of all the molted skins being added to the scale-covering the male adds but one, the first, and the skins molted subsequently are pushed out from under the scale.* When the male reaches maturity it becomes a small, delicate, two-winged insect and in this form issues from beneath the scale that has protected it.

The development of a generation, from time of birth to maturity, varies from four to six weeks, according to the prevailing temperature and the time of year. Within a few days after

*Howard & Marlatt, Bul. No. 3, n. ser., Div. of Entomology.

reaching maturity, and after having been fertilized, the female commences giving birth to living young and continues bringing forth living young for a period (in summer) of about six weeks. Observations made by the writer in Southern Georgia indicate that in the southernmost parts of the United States, young may be produced at almost any time during the winter, during a continued warm spell, the females suspending operations whenever a cold snap makes its appearance. At Moultrie, Ga., Prof. W. M. Scott found active larvae during twelve months in the year, and as there is considerable territory in Louisiana that is south of the latitude of Moultrie it would not be at all surprising to learn that the insect breeds during the entire year in the lower Mississippi Valley, or in those sections south of New Orleans.

During the productive period of six weeks or over, the female insect gives birth to from 150 to 500 young and as these commence their development soon after birth, it is readily seen that in a short time individuals of all ages are found upon infested trees. As a result it is impossible by mid-summer to distinguish one generation from another. Dr. Howard found that in the latitude of Washington, D. C., there were at least four generations per year and perhaps a partial fifth generation. As far South as Louisiana there seems little doubt but that there are at least six full generations during the year and possibly more.

When one considers the rapidity with which these insects reach maturity and the enormous number of young produced by a single female, some idea of their capacity for destruction is obtained. Dr. Howard has estimated, conservatively, that the progeny of a single pair may, in the course of a single season, amount to the enormous number of 3,216,080,400.*

Means of Dissemination.

Dissemination may well be considered under two heads, dissemination locally from tree to tree and from orchard to orchard, and dissemination over long distances, as from one locality to another.

*Bulletin No. 3, n. ser., Div. of Entomology.

The spread from orchard to orchard, or from one tree to another in any given orchard, is entirely through the agency of the young crawling lice. As the males, although winged, cannot of themselves disseminate the species and as the females remain in one spot during their entire lifetime, it will be seen that neither the adult females nor males can directly cause new infestations, or even infestation of adjoining trees. However, the young lice crawl about readily during the first few hours of their existence and where the branches of the trees interlock they crawl readily from one tree to another. Birds, alighting upon badly infested trees, get the small lice upon their feet and when they afterwards alight upon other trees the lice crawl off to locate upon the twigs and limbs and commence their development. The transportation of the lice by birds is of such common occurrence that many inspectors, when entering an orchard for the purpose of looking for San Jose scale, go directly to birds' nests, if any are in view, and examine the twigs immediately surrounding them. In nearly all infested orchards, and even in many cases where the infestation is still very light, the scales are found in greater abundance around birds' nests than elsewhere in the immediate vicinity. This also accounts for the fact that a belt of heavy timber between orchards is a very effectual barrier to the natural spread of the scale from one orchard to the other. Birds coming from an infested orchard are not likely to pass through a belt of timber to another orchard without alighting upon the forest trees and loitering about more or less, during which time the lice upon their feet and legs have an opportunity to get off. It is quite likely that the many large insects which frequent orchards are instrumental in carrying the young San Jose scale lice from tree to tree, and in fact the writer once found two of these young lice upon a large flower beetle (*Allorhina*) taken in an orchard where the scale occurred.

Horses and mules used in cultivating orchards and nurseries jar the limbs with which they come in contact and thus get the young lice upon them. The lice are again rubbed or shaken off on to other trees some distance away, as is evidenced by the fact that in peach orchards where the cultivation is in only one direction the spread of the scale is invariably greatest in the direction of cultivation and not at an angle to it.

Quite conclusive evidence that the San Jose scale is thus disseminated upon teams and tools was found during the past season in a block of nursery stock about 200 yards in length and about 50 yards in width, the rows running lengthwise of the block. This entire block had been budded in the spring of 1904 with buds shipped from a distance. Upon examination of this block of nursery stock in October, 1905, an occasional tree was found which was practically incrusted with the San Jose scale, the infestation being much the heaviest upon the lower part of the trunk near the point where the bud had been inserted. Evidently these trees became infested as the result of an occasional bud of the original lot bearing one or more scales. That the number of scales on the buds was very small was evidenced by the small number of trees infested in this manner. In several other portions of the same block many trees were found infested with but a few scales, and these scales were in all cases upon the side limbs and upon the tops, never upon the lower part of the trunks. The distribution of the scale through this block in such a manner (See Figure 9) cannot be explained except by the supposition that the minute lice were carried from the heavily-infested trees to the others upon the horses or harness used in cultivating the trees.

Mr. R. I. Smith, State Entomologist of Georgia, cites a case in which peach pickers evidently carried the scale from one orchard to another. In the forenoon of a certain day the "gang" of pickers worked in an infested orchard and in the afternoon of the same day worked, with the same baskets, in an uninfested orchard some distance away. A few months later infestation by the scale was found in the latter orchard and was most in evidence near the point where the pickers had first entered when coming from the infested one.

It seems likely that winds may blow the young lice from one tree to another and it seems to the writer not at all improbable that whirlwinds, such as are often prevalent during the dry summer months, may take up hundreds of these lice from an infested tree, only to let them descend broadcast over a considerable area when the force of the whirlwind is expended. This, while a theory only, would account for many peculiar cases of local distribution which seem inexplicable in any other way.

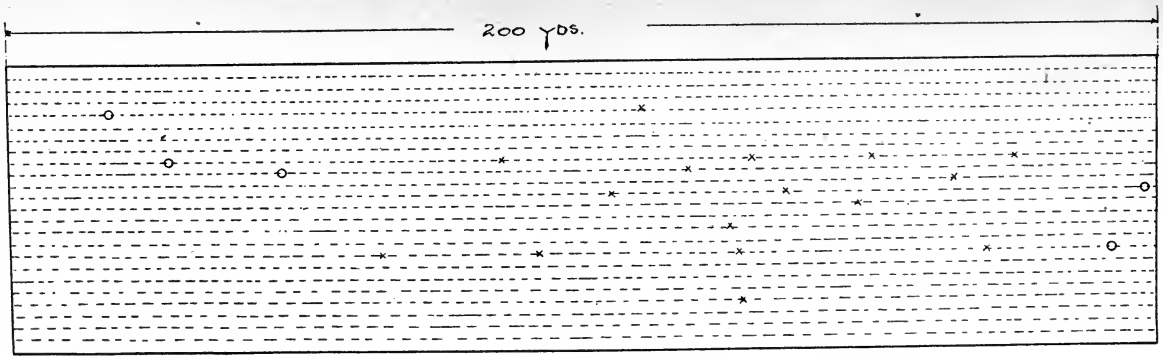


FIG. 9.—Diagram illustrating how San Jose scale is distributed by teams and tools used in cultivating orchards and nurseries. The diagram illustrates the actual conditions found in a block of nursery stock in October, 1905. The trees were budded in the spring of 1904, a few of the buds being infested, resulting in heavily infested trees at the points marked by circles. During 1905 the scale was distributed along the rows of trees (indicated by dotted lines) and resulted in twig-infestation of trees at the points indicated by the cross-marks.

Many people have thought, and with good reason, that the scale might be distributed upon scale-infested fruit, such as apples or pears. While an infestation might result from the indiscriminate throwing of infested fruit or parings into or among susceptible plants, still we believe that very few infestations actually obtain a start in this manner. A few years ago, the writer conducted experiments under the direction of Prof. F. M. Webster, in Ohio, in which infested fruit and parings from infested pears and apples were placed in contact with the trunks of young apple trees, but no infestation of the latter could be detected up to a year afterwards, at which time the observations had to be abandoned.

Where infested trees are pruned late in the spring or early in the summer, it is possible for the pruned twigs or limbs to carry living scales, as well as young lice, for some little time, and if thrown among uninfested trees or plants an infestation of the latter might easily result.

Infestation of nurseries frequently results from the taking of budding or grafting wood from trees in infested orchards. Many nurserymen prefer to secure their buds from bearing trees whenever possible in order to be certain that their trees are true to name. Slight orchard infestations by the scale are very easily overlooked and hence it often happens that twigs are cut for grafting or budding purposes which have upon them a few scales. Occasionally individual scales are concealed beneath a bud and are invisible until the bud is actually removed. A single fertilized female is, of course, able to start an infestation that in the end will prove as serious as if the infestation had been by hundreds of thousands of scales. Doubtless more nurseries have become infested in this manner than in any other, barring possibly the purchase of stock from infested nurseries, for when even a few lightly infested trees are "lined out" with healthy nursery stock the infestation spreads over a considerable area of the nursery during the first season.

Nurserymen can guard to good advantage against infestation by budding or grafting wood by having the orchards from which the wood is to be taken inspected annually by a skilled inspector. This is practiced by the majority of progressive nurserymen in

Georgia, and in dozens of instances infestation of nurseries has been prevented by the inspector finding San Jose scale in the orchards from which the nurserymen intended to obtain buds or grafts, and advising the nurserymen regarding the danger of obtaining buds from these sources. The fumigation of all budding and grafting wood (in the case of deciduous trees only) with hydrocyanic acid gas before use is likewise a good precaution for every nurseryman to take.

Dissemination of the San Jose Scale over long distances, and from one portion of the country to another, is almost entirely by the shipment of infested nursery stock. Nurserymen cannot conveniently grow all of the fruits and plants which their customers are likely to call for, and it is often also impossible for the nurseryman to foresee the extent of a season's demand for fruits of certain varieties. Hence it comes about that almost every nurseryman has occasion to purchase stock from other nurseries, and in order to secure varieties demanded by his trade it is often necessary for him to make these purchases from nursery firms many hundreds of miles distant. Naturally he is often ignorant of the conditions surrounding these latter nurseries and of the extent to which their stock has been exposed to possible infestation. Hence the scale is not infrequently shipped from one nursery to another, with the result that the nurseryman receiving the infested stock gets the majority of his own trees infested in turn and distributes them—often without a knowledge of their true condition and without malicious intent—to his customers. As stated upon a previous page, the progress of the San Jose scale from California to New Jersey and thence to nearly every State east of the Rocky Mountains has been clearly proven to have been by shipments of nursery stock.

The only logical and practical way to prevent the spread and dissemination of San Jose scale through shipments of nursery stock is by the enforcement of a practical quarantine law whereby every nurseryman is required to have his stock inspected annually by a competent inspector, under State supervision. Such a quarantine law should successfully prevent the sale or shipment of stock from infested nurseries under any and all circumstances. The State Crop Pest Commission has enacted quarantine regula-

tions (having the force of law) which it is believed will meet these requirements. Particular mention of these regulations is made upon a subsequent page.

In addition to the inspection of nursery stock, the proper fumigation of this stock affords an additional safeguard against the scale. Individual San Jose scales are very minute objects for which to search among hundreds or thousands of growing trees, and while a competent inspector, after a careful examination, may be able to say that in all probability this pest is not present in a given lot of nursery stock, still from the very nature of the case he cannot *guarantee* that the stock is absolutely free from this insect. Likewise, while a thorough fumigation with hydrocyanic acid gas will in the great majority of cases kill all scales upon infested trees, the fumigation process, for a number of reasons, is by no means infallible. Hence it is clearly seen that trees which have not only been inspected, but which have also been properly fumigated, are the safest trees for the orchardist and farmer to buy. Infested trees should never be sold under any circumstances, regardless of how many times or how carefully they have been fumigated, and the fruit-grower who is watchful of his own interests will firmly refuse to purchase stock of nurserymen who are not provided with an inspection certificate, and will by preference make his purchases from nurserymen who also make a practice of carefully fumigating all trees which they ship or sell.

Nurserymen can profitably guard against infestation of their nurseries by not only purchasing fumigated stock, but they can wisely fumigate all stock which they receive, regardless of whether it has been previously fumigated by other parties or not.

Control of the San Jose Scale by Spraying.

Having in the previous paragraphs, touched upon the means by which the San Jose scale is distributed and the means by which both nurserymen and orchardists can be protected from infestation of their premises by the proper enforcement of quarantine and inspection regulations, and how orchardists can further guard against this pest by purchasing only trees which have been fumigated, we come now to consider the case of the man who is so

unfortunate as to already have this destructive insect in his orchard or ornamental grounds.

Serious as the San Jose scale is, it can nevertheless be kept fully under control when occurring upon deciduous trees. This fact, however, cannot be taken as justification for introducing it into one's orchard or even for neglecting in the slightest degree those quarantine restrictions which prevent or limit its distribution. The treatment of infested orchards, while not particularly expensive, is nevertheless an expense which the fruit-grower does

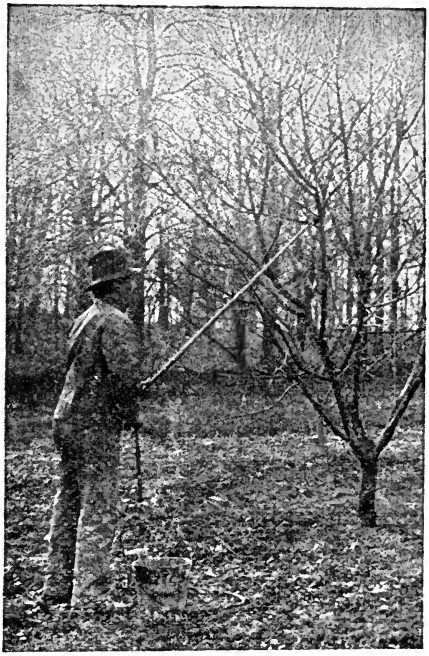


FIG. 10.—Spraying trees with the "bucket pump." (After photo by Britton, Conn. Exp. Station.)

not have to incur so long as his orchard is free from the pest. The medical fraternity has quite recently demonstrated its ability to not only control, but to exterminate entirely, yellow fever, but no community of intelligent citizens would purposely permit the introduction of this disease simply because it can be controlled by the physicians. The same logic applies with equal force to the introduction of serious diseases and insect pests of fruit and other crops.

Ever since the appearance of the San Jose scale east of the Rocky Mountains the Experiment Stations and entomologists of nearly every State have continuously and carefully conducted experiments with various remedies for this pest. Fumigation of infested trees under large tents or boxes was early attempted, but this process, though remarkably successful in its effects upon the scale, was not found practical, owing to its comparatively enormous expense and the necessity of having a somewhat complicated and expensive equipment for the work.

It is not necessary for us to review the various compounds and sprays, including oils of various kinds, caustic soda, emulsions of carbolic acid, "patent" preparations, etc., that have been at one time and another tested and advocated as remedies for this scale.

THE LIME-SULPHUR WASH.

After tests of many different preparations the one known as the "lime-sulphur-salt" wash, or "lime-sulphur" wash, has been found universally more effective than any other preparation. As this is a preparation that can be made by any fruit-grower or farmer with very little expense for apparatus, and as he has no profits to pay to anyone, except such profits as are made upon the raw materials (sulphur and lime), it is a remedy all the more desirable. As to the exact proportions of lime, sulphur and water necessary to insure the best results, both entomologists and fruit-growers differ considerably. The proportions given below are those which gave the best results, at a minimum of cost, in a long series of experiments made by the Georgia State Board of Entomology, in which the writer participated. Although we have not thus far experimented with this remedy in Louisiana, the conditions, so far as the culture of deciduous fruit trees is concerned, do not appear to differ materially from those obtaining in Georgia, and there is no conceivable reason why these preparations will not be fully as effective in Louisiana as in Georgia or any other State.

In preparing the lime-sulphur wash the best quality of stone lime should be used; lime which contains pebbles or flinty matter is undesirable. Ordinary ground sulphur, or "flour of sulphur"

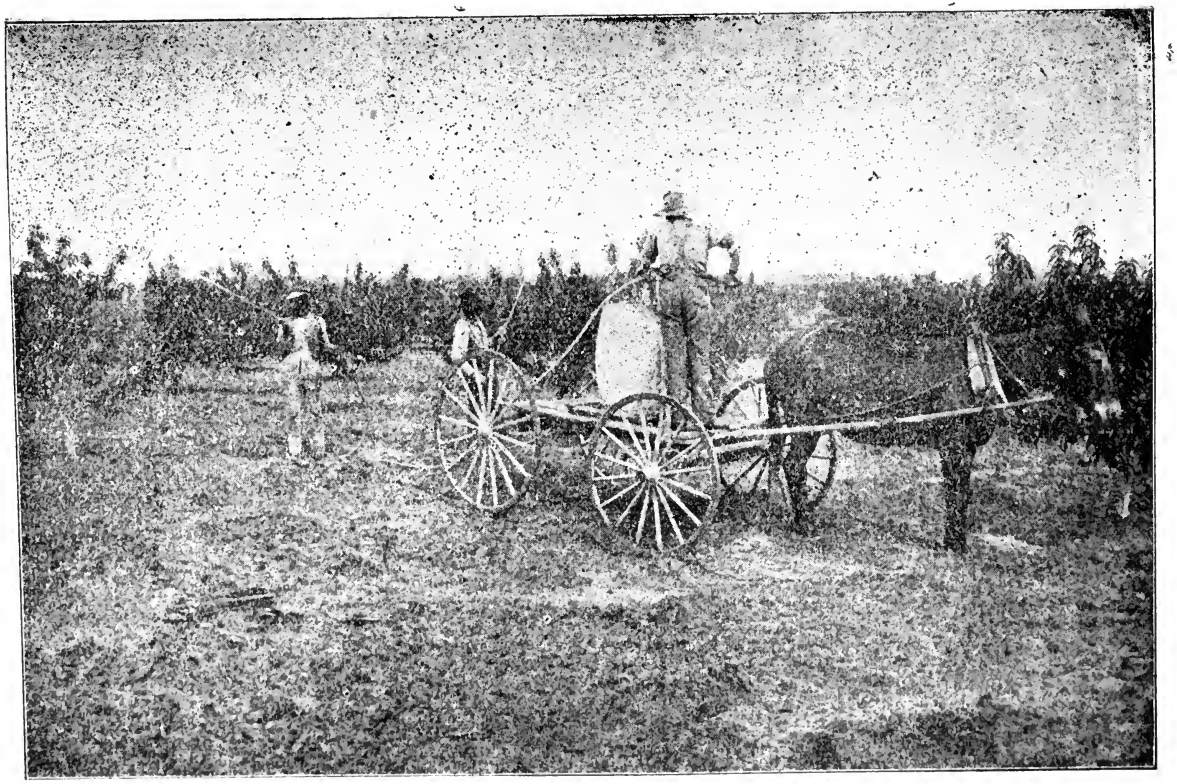


FIG. 11.—A suitable spraying outfit for a medium-sized orchard. Eclipse pump mounted in barrel, two leads of 20-foot hose, 6-ft. iron extension rods and single Vermorel nozzles. (After Newell & Smith, Bul. 14, Ga. State Board of Entomology.)

should be used. While theoretically "roll sulphur" ought to answer the requirements, its use is not practicable, owing to the fact that it is much more difficult to get into solution with the lime than is the ground sulphur. Fruit-growers should guard against the exorbitant prices sometimes charged for sulphur by druggists and dealers. A price of five cents per pound, for small quantities, usually allows the druggist a profit of 100 per cent. or better, which is amply sufficient. When ground sulphur is purchased by the barrel a price of three cents or three and one-half cents per pound at the initial shipping point is as high a price as the fruit-grower should consent to pay.

The proportions of lime, sulphur and water, which have given the best results and which combine with effectiveness the utilization of the smallest possible amount of material, are as follows:

Stone lime	21 pounds
Sulphur	18 pounds
Water	50 gallons

To prepare the lime-sulphur mixture place a few gallons of water in an iron kettle (preferably one holding 50 gallons or more) suitably mounted upon a base or brick arch over a fire, and bring this water to a boil. While the water is heating weigh out the stone lime required and place it to one side. Also weigh out the sulphur and mix it with just enough cold water to make a thick paste. Sulphur will not dissolve in water, but by stirring vigorously the sulphur and water can be made into a heavy paste which contains no dry sulphur.

When the water in the kettle has come to a full boil, dump in the sulphur paste, stir quickly with a long paddle to mix it well with the hot water and then immediately add the stone lime.

A very violent boiling will result from the rapid slaking of the lime in the hot water. This is exactly what is desired, for with the combined heat of the boiling water and that produced by the rapid slaking of the lime a higher temperature is obtained than can be secured by mere boiling alone. This sudden heating and violent agitation causes a considerable part of the sulphur to unite with the lime. When the violent reaction in-

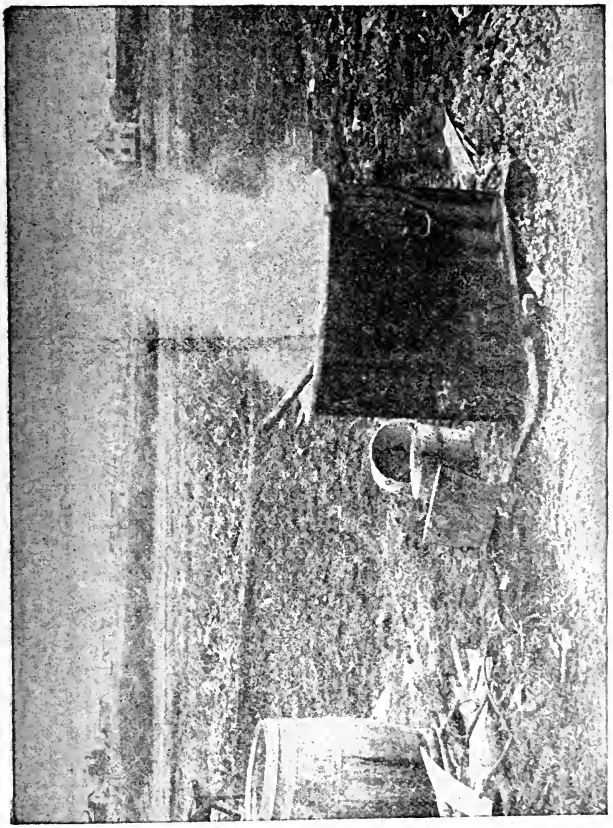


FIG. 12.—"Kettle outfit," in use boiling the lime-sulphur preparation (After Britton, Conn. Exp. Station.)

duced by the slaking of the lime has subsided, boiling should be continued for at least thirty-five minutes, water being added from time to time to keep the mixture thin enough to stir and to make up for evaporation.

After boiling for 35 minutes or more, water should be added to make the full 50 gallons of mixture. Either hot or cold water can be used for diluting. If desired, the mixture can be taken from the kettle and placed in a barrel and the water then added. The mixture should be taken immediately to the orchard and sprayed upon the trees while still warm. If the entire lot is not sprayed out at once, as would be the case when a bucket pump is used, the mixture should be left in the kettle and kept at or near the boiling point until used or until the day's spraying has been finished. There is no possible danger of the mixture being sprayed upon the trees *too* hot, as the fine mist from the nozzle will be lowered in temperature before it comes in contact with the tree, even though the liquid in the spray tank be boiling hot. The warm mixture passes through the pipes and nozzles much more readily than does the cold and with less liability of clogging the nozzles. In fact, when this mixture is allowed to cool a large number of crystals are formed.*

These crystals can be re-dissolved by again heating the mixture, but as a usual thing time and labor are saved by making no more of the lime-sulphur mixture than will be used during the day's work of spraying.

Where one or more barrel pumps are used and the liquid sprayed out quite rapidly, two kettles are required to prepare the mixture as fast as needed. One man with two 50-gallon kettles can usually prepare the mixture fast enough to keep two barrel pumps constantly supplied.

When several thousand trees are to be sprayed and where economy of time and labor is an important factor the use of a steam boiling plant is desirable, the cooking of the mixture being done in barrels or small tanks with steam, instead of in iron ket-

*Opinions of different writers are quite at variance as to the composition of these crystals. Prof. C. O. Houghton in a recent paper (Bulletin 64, Del. Exp. Station) gives their composition as hydrosulphide of lime, with the chemical formula $CA(SH)_2$.

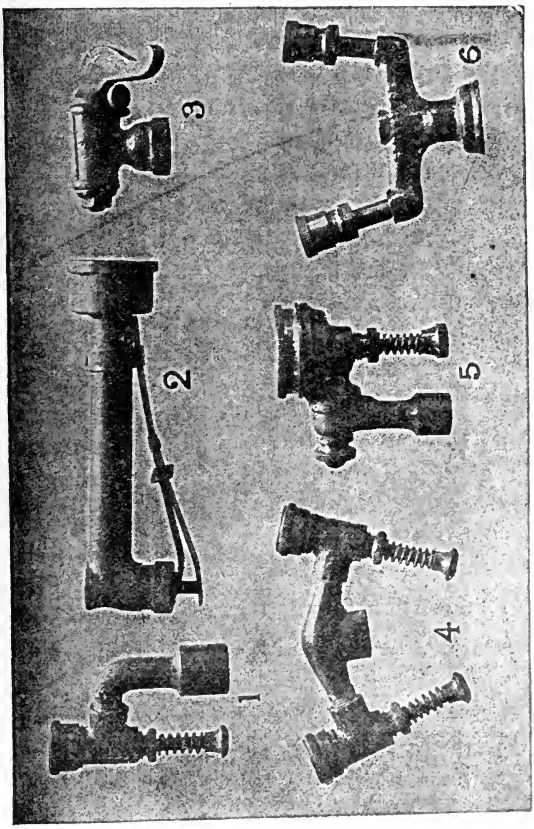


FIG. 13.—Common types of spray nozzles: 1, Vermorel; 2, McGowen; 3, Bordeaux; 4, Double Vermorel; 5, Mistry; 6, Double Spray-motor. (After Britton, Conn. Exp. Station Bulletin.)

tles over a fire. The boiler at a ginhouse or sawmill, if conveniently located, can be used as the source of the steam. Portable boilers such as are used in sawing wood, or even steam feed cookers, can be utilized. Where large orchards are to be sprayed, the purchase of a boiler especially for the purpose is justified. In arranging such a plant its size will, of course, be dependent largely upon the amount of the mixture required daily. Barrels should be provided in which to boil the mixture, and these barrels should be so placed upon a raised platform that the liquid when made can be drawn off directly into the spray tank or barrel without the labor of handling it with buckets. Steam from the boiler should be conveyed through an iron pipe to or near the bottom of each barrel, the steam supply to each barrel being controlled by a globe valve conveniently located. If water pressure is available a water pipe or hose should be run to each barrel to facilitate filling. If a well or stream is near the boiling plant a water supply is readily obtained by use of a steam jet.

The preparation of the mixture when steam is used differs in no essential respect from the preparation in a kettle. A small part of the water is brought to a boil in the barrel, the sulphur paste added and this followed by the lime. With a good pressure of steam it is not necessary to boil as long as where a kettle is used. Boiling should always be continued until a greenish-yellow tinge is imparted to the mixture. The particular color required is soon recognized after a little experience. In case of doubt, the boiling should be continued for at least 35 minutes or more, as it cannot be boiled too much. In recommending this 35 minute period of boiling, a *violent* boiling is meant. Mere simmering does not bring about the chemical union of the lime and sulphur which is essential to the success of the wash.

The exact arrangement of the boiler, steam and water pipes, barrels, etc., will vary according to the conditions under which the plant is arranged. Figure 15, showing a small steam boiling plant, will convey an idea of how such a plant may be constructed to good advantage.

THE LIME-SULPHUR-SODA WASH.

Upon private grounds and upon small premises in town or city, many people do not like to go to the trouble of making the

boiled lime-sulphur mixture. For such conditions the lime-sulphur-soda mixture, a modification of the fore-going, which does not require boiling with steam or over a fire, can be made with less trouble, and while not nearly so effective as the boiled preparation is, nevertheless, a very effective agency against the scale. This wash is prepared as follows:

Lime	16 pounds
Sulphur	8 pounds
Commercial Caustic Soda	8 pounds
Water	50 gallons

Mix the sulphur into a thick paste *with boiling hot* water. Then add the caustic soda slowly (do not dissolve the soda in water) keeping the mixture thoroughly stirred. A brick-red color will appear almost at once. Continue the addition of the caustic soda and continue stirring, adding small amounts of *hot* water when necessary to prevent the mixture from becoming too thick. The soda should dissolve all of the sulphur in a few minutes, producing a clear, deep red liquid. Unless the liquid is entirely clear, with no particles of undissolved sulphur remaining, the mixture must be heated until all sulphur is dissolved. *It is absolutely imperative that all sulphur be dissolved and a clear liquid obtained, before the lime is added.* To the clear liquid described, add the stone lime, previously weighed out, and while it is slaking keep well stirred. The completed preparation will have the characteristic yellowish-green color of the regular lime-sulphur preparations. Dilute with cold or hot water to the desired point and spray while hot, as directed above for the lime-sulphur wash.

This mixture is decidedly caustic and the usual precautions must be taken to protect the hands and face. Badly infested trees should always receive two sprayings, one in December and the other early in February before the buds commence to swell.

Neither this mixture nor the lime-sulphur wash can be used upon citrus trees or upon evergreens. On account of their caustic properties the use of these preparations is confined strictly to deciduous trees, *i. e.* those which shed their leaves in autumn and become thoroughly dormant during the winter months.

This mixture, as well as the lime-sulphur preparation, should be strained after being diluted and before being placed in the spray tank. A suitable strainer for this purpose is shown in Figure 14 and can be made from an ordinary wooden bucket by screwing a piece of one or two-inch gas pipe into the bottom and inserting a piece of wire cloth (having about 18 or 20 meshes to the inch) in the bucket itself.

FIG. 14.—A serviceable home-made strainer for straining lime-sulphur mixtures. Made by placing wire-cloth in an ordinary water bucket and inserting a piece of gas pipe in the bottom. (From a photo by W. E. Britton, Conn. Exp. Station.)

WHEN TO SPRAY.

For full and satisfactory control of the San Jose scale winter spraying alone must be depended upon. Although reference is made upon a subsequent page to "summer treatment," the latter does not result in more than a checking of the rate of increase and cannot in any sense be considered a remedy. Spraying of orchards for this pest must be done in winter, and spraying with the lime-sulphur mixture must not be done until the trees have become thoroughly dormant in the fall or early winter. In the case of orchards lightly infested one spraying, if carefully done, will keep the scale in check until the following winter, but where the pest has obtained a good foothold and some of the trees are "incrusted," two sprayings should be given to get the insect fully in subjection and to prevent serious damage to the trees during the ensuing year. When two sprayings are given, the first should be as soon as possible after all the leaves have fallen from the trees and the sap has ceased circulating. The period best adapted for this work in Louisiana is during December. The second spraying should be given late in January or early in February, the object being to put on this application as late as

possible so that much of it will remain on until after the scale insects commence breeding in the spring.*

Application of lime-sulphur after the buds have commenced to swell results in these being killed and the crop lost. As peach buds, especially in Southern Louisiana, frequently swell with a warm period in February, the second spraying should be completed not later than February 10th. In orchards where there is but a slight infestation, or where the scales have been brought fully under control by two sprayings the previous winter and have not increased to any great extent, one application only is necessary and this should be made late in January or early in February. Where one spraying is depended upon, special pains should be taken to make it thorough. Although the lime-sulphur is sure and certain death to fruit buds that are opening, absolutely no danger to either buds or trees is incurred when the wash is applied to thoroughly dormant trees.

When the scale has once been brought under control by two sprayings during one winter, subsequent control is usually insured by one spraying a year, and where the work has been carefully done we have known orchards to go for two years after spraying without requiring additional applications. In spite of the fact that this preparation will keep the scale fully under control, will prevent injury to the trees by the scale and still permit the production of more and better fruit than is possible in an uninfested unsprayed orchard, the fruit-grower should not entertain the hope than by this spraying he will entirely exterminate the scale. Some few individuals always escape to ultimately reinfest the orchard, and although we have seen several peach orchards in which not a single scale could be found for several months after the spraying, we have yet to find an orchard in which the pest was killed "to stay killed."

*The lime-sulphur wash is not immediately fatal to more than a small per cent. of the scale-insects but, unlike most insecticides, its action is slow and is continuous for several weeks after its application to the trees. A chemical study of this mixture, made by J. K. Haywood (Journal Am. Chemical Society, Vol. 27, pp. 244-255) showed the completed mixture to contain sulphur as free sulphur and as calcium sulphites, sulphates and the thiosulphate. Upon exposure to the atmospheric conditions after spraying, the thiosulphate gradually decomposes, liberating finely divided sulphur and sulphites, the final result being free sulphur and calcium sulphate. The finely divided mineral sulphur is thought by the author quoted to be the effective agent in killing the scale-insects.

The lime-sulphur wash is destructive to such insects as the cherry scale and Putnam's scale, which occur in greater or less numbers in almost every orchard, and it undoubtedly kills a great many of the younger peach tree borers. It is also a powerful disinfectant and destroys the spores of the peach leaf-curl disease and of other fungi which do more or less injury and retard the proper development of both trees and fruit. Its beneficial work in destroying these various insects and fungi more than repays its cost, independently of its effect upon the San Jose scale. As a result, infested orchards properly sprayed with the lime-sulphur are often in better condition, and produce more and better fruit, than orchards which are not infested with scale and which are not treated with this wash. Mr. J. H. Hale, one of the most extensive and successful peach growers in the United States, has used this preparation for several years past in his orchards of several hundred acres at Ft. Valley, Ga., and is enthusiastic over the results obtained by its use, both in its effect upon the San Jose scale and in its effect in keeping the trees in much cleaner and healthier condition generally than they otherwise would be.

How to Spray and Spraying Apparatus Needed.

In spraying an infested tree the object should be to place an even, uniform coating of the wash over every particle of bark that is above ground. Peach orchards should be pruned before spraying rather than afterwards as the pruning lessens the area upon each tree to be covered with the spray and also leaves the balance of the tree more accessible to the operator. With the lime-sulphur mixture a Vermorel or Mistry nozzle is preferable to any other and it should have a medium-sized aperture through which the spray is discharged. A nozzle with too large an opening results in a waste of the spraying material, while one with too small an aperture is usually responsible either for lost time or the application of an insufficient amount of the mixture. In spraying a tree the spray should first be directed against the uppermost and outermost tips of the twigs and these followed down to the trunk, moving the nozzle slowly to secure a uniform and even distribution of the spray on every bud and particle of surface. After all the twigs and limbs have been

treated in this manner the trunk itself should receive a thorough coating. As the operator sprays, it is necessary for him to move around the tree so as to coat each limb and twig upon all sides. While it may appear to the reader that to spray a tree in this thorough manner would require considerable time, as a matter of fact, one who is accustomed to "handling the nozzle" will spray an ordinary sized peach tree in from one to two minutes. Spraying in a strong wind cannot be done satisfactorily, but where there is only a light breeze the operator will soon learn that by commencing with the nozzle directed against the wind, but at an angle to it, he can move around the tree and reach every side of it without being compelled at any time to get directly upon the leeward side of the tree where the spray will be blown upon him.

The lime-sulphur, in order to be an effective agent against the scale-insect and to penetrate the scale-covering, must of necessity be strong and corrosive in its action and if the operator's face and hands are continually wet with it they will become sore. For this reason the operator must guard against the spray being blown into his face, or if careless, should protect his face with a mask of heavy cloth. The fittings of the hose and nozzle should be kept tight so that the liquid will not be continually leaking out and getting upon the hands of the operator. A pair of cheap leather gloves forms an effective protection for the hands.

After the first application has dried upon the trees, the latter appear as if covered with a coating of white lead, and all spots that have been missed in the spraying are easily seen. The orchard should now be gone over again the second time and all of these unsprayed spots properly coated with the wash.

In the choice of spray pumps the orchardist has a wide variety from which to choose, and the pump decided upon for the work should be dependent largely upon the number of trees to be treated. A cheap, flimsy affair of tin or copper, such as is used by many gardeners, cannot be used for the application of the lime-sulphur, for, in the first place, copper is entirely corroded and eaten up in a short time by this mixture, and, in the second place, these cheap pumps are so constructed that the

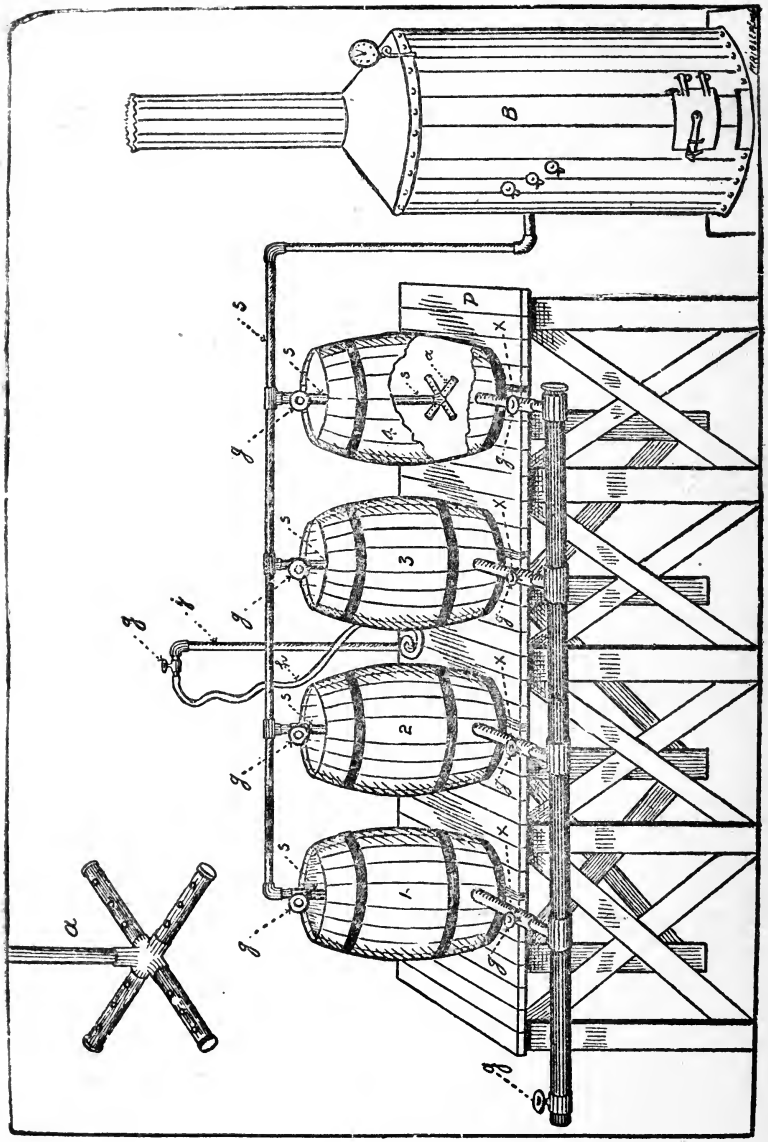


FIG. 15.—A Simple Steam Boiling Outfit for Preparing Lime-Sulphur Washes: *B*, boiler; *ss*, steam pipes; *gg*, globe valves; 1, 2, 3 and 4, 50-gallon barrels; *xx*, pipes for drawing off mixture after boiling; F, large pipe carrying liquid from pipes to wagon tank or spray-barrel; *a*, lower end of steam-pipe with cross-arms and one-eighth inch openings for escape of steam; P, platform 6 feet above ground; *j*, pipe supplying water from elevated tank or steam-jet; *h*, water hose for carrying clear water to 1, 2, 3 and 4. (After Newell & Smith, Bul. No. 14, Ga. State Board of Entomology.)

spraying material invariably gets all over the operator and through his clothing. The use of such pumps under any circumstances for spraying any material whatsoever is only a make-shift that can hardly be commended.

The use of knapsack pumps with the lime-sulphur is not practicable.

For use with the lime-sulphur wash a substantial, well-made pump of brass should be used and it should in all cases be equipped with a long line of hose and an extension pipe so that the operator can conveniently reach all parts of the trees or plants to be sprayed.

In private grounds and in small orchards a bucket pump, costing in the neighborhood of $7.00 to $9.00 is amply sufficient for the work when properly provided with hose and pipes. As sent out by the factories, these bucket pumps are equipped with a three-foot length of hose to which the nozzle is attached. To spray tall orchard trees with such an outfit is impossible. However, the short length of hose can be removed and a hose ten to fifteen feet in length can be substituted. To the distal end of the hose an extension pipe (which need be nothing more elaborate than a length of ordinary iron gas pipe upon which threads are cut for screwing on the nozzle) should be attached and on the end of this the nozzle should be placed. Almost any factory or dealer in spraying machinery will furnish bucket pumps equipped in this manner if requested to do so. While such an outfit can be used by one man working alone, better and more satisfactory spraying can be accomplished by two. In the latter case one man can pump while the other directs his entire attention to the use of the nozzle, the long lead of hose and extension pipe (which latter should be about six feet in length), permitting him to move about with perfect freedom and reach all parts of the tree. An outfit of this kind is shown in Figure 10.

In orchards of over one or two hundred trees the spraying can be carried on much more rapidly by the use of a barrel pump, costing from $12.00 to $20.00. While the bucket pump outfit can of course be used for spraying any number of trees, still the use of a barrel pump equipped with two leads of hose and having a capacity of about 50 gallons at each filling affects such a saving of time that its use is economical in the end. Like the bucket

pump, the barrel pump should have all fittings perfectly tight and should have leads of hose from twenty to twenty-five feet in length to which extension rods are attached. Where an extension rod is not readily obtainable a wooden pole may be tied to the hose near the nozzle, and will answer the same purpose as a regular extension pipe, although by no means as convenient and easy to handle.

In very large orchards it is customary to mount the spray pumps in wagon tanks having a capacity of from 200 to 300 gallons so that one load of spraying material will last from two to three hours. This, of course, affects a material saving in time lost by the spray hands. These wagon tanks are not expensive, costing from $10.00 to $20.00, but unless the orchard to be sprayed contains several thousand trees the purchase of such a tank by the fruit-grower is unnecessary.

After each day's spraying the pumps and attachments should be well rinsed out with clear water and after the season's spraying is completed all parts of the pump should be thoroughly cleaned and oiled before being stored away.

The fruit-grower may occasionally encounter difficulties which are not fully covered in this short discussion of spraying materials and methods. In all such cases the writer will take pleasure in answering fully, free of charge, any inquiry that may be made.

Summer Treatment for the San Jose Scale.

As was stated upon a previous page, substances which are corrosive enough in their action to kill the San Jose scale are too strong to be applied to trees while they are in a growing condition. For this reason no treatment is known that will control the San Jose scale effectively, if applied while the trees are in leaf or fruit.

In case of infestations which are discovered in mid-summer and where the infestation is so bad that it appears unlikely that the trees will survive until winter treatment can be given them, the regular lime-sulphur wash described above can be made and applied to the trunks of the trees and to the bases of the lower limbs with a whitewash brush (but must not be applied to the foliage or young growth). This will check the increase of the scale upon these portions, where it is usually most abundant, and

will be of assistance to the tree in resisting the damage by the pest until winter, when a thorough treatment can be given. In some cases the application of a 15 per cent kerosene emulsion* (to the entire tree, foliage and all) will kill all young lice and some of the older insects as well, but in the course of a couple of weeks after spraying the young lice are again as abundant as ever, and such sprayings, to have any material effect upon the scale, must be repeated every two or three weeks until the end of the season. Any summer treatment that may be undertaken should be considered as no more than an agency in reducing the rate of multiplication of the insects until a thorough spraying with the lime-sulphur can be given during the winter following.

Manufacturers of, and Dealers in, Spraying Machinery.

For the convenience of those who contemplate the control of this or other fruit insects upon their premises, we give below a list of some of the manufacturers and dealers in spraying machinery. The fruit-grower who has in mind the purchase of a spraying outfit will do well to secure catalogues from several of these firms and from these he will be able to obtain much information regarding spraying machinery and will be enabled to select an outfit suited to his particular requirements:

Goulds Manufacturing Co., Seneca Falls, N. Y.
The Deming Company, Salem, Ohio.
Morrill & Morley, Benton Harbor, Mich.
Field Force Pump Co., Elmira, N. Y.
F. E. Myers Pump Co., Ashland, Ohio.
Wm. Stahl, Quincy, Ill.
Spray-Motor Co., Buffalo, N. Y.
Beck & Gregg Hardware Co., Atlanta, Ga.
P. J. Berckmans Co., Augusta, Ga.

*Kerosene emulsion can be made from 4 pounds of whale-oil (or good laundry) soap, 4 gallons of water and 8 gallons of kerosene as follows: Weigh the soap carefully and place with the water in a vessel over the fire, using a slight excess of water to make up for evaporation. Fit a pump with a straight piece of hose, to which is attached a nozzle for throwing a straight stream 3-16 or 1-4 inch in diameter. Pour the oil into a barrel or tub in which the pump is set and when the soap is dissolved and the solution begins to boil, add it to the oil (away from the fire) and pump the whole vigorously back into itself for a period of at least ten minutes. The stream from the nozzle should be directed straight downward into the mixture so as to agitate it to the very bottom. After a few minutes the oil and soap solution will be seen to combine, forming a thick, creamy solution which when perfectly made will remain without change for several days. For a 20 per cent. strength add water to make a total of 40 gallons; for a 15 per cent. strength add water to make 54 gallons, and for a 10 per cent strength add water to make 80 gallons and agitate thoroughly before use.

RULES AND REGULATIONS OF THE STATE CROP PEST COMMISSION OF LOUISIANA.

Governing the Inspection of Nurseries and the Shipment of Fruit Trees and Other Nursery Stock Into or Within the State.

For convenient reference, we give below such Rules and Regulations of the State Crop Pest Commission* as provide for the inspection of nurseries offering nursery stock for sale in the State of Louisiana, and such Regulations as govern shipments of nursery stock into this State from other states or countries. A full copy of all the Regulations of the Commission may be obtained free of charge upon application to the Secretary of the Commission.

"SECTION VIII.

"(a) No firm, person or corporation shall sell, ship, exchange, deliver or give away, within the State of Louisiana, any trees, vines, shrubs, buds, cuttings or plants, or parts of plants, known to be infested with the San Jose scale.

"(b) All nursery stock shipped into this State from any other State or country shall be prominently labeled with a certificate of inspection signed by the State Entomologist or other duly authorized official of the State or country in which said stock was grown. Shipments not so labeled shall be liable to confiscation upon the order of the Entomologist of the Crop Pest Commission.

"(c) Transportation companies and their agents shall immediately notify the Secretary of the Crop Pest Commission (Shreveport, Louisiana), when by oversight, negligence or otherwise, any shipment of nursery stock without a proper certificate attached, shall arrive at any station or wharf in this State, and it shall be the duty of the Secretary to proceed as speedily as possible, by himself or his assistant, to investigate and dispose of such shipment.

"(d) The Entomologist and his assistants shall have authority to inspect any shipment of nursery stock at any station or wharf in this State, and shall have authority to stop any nursery stock when in transit, for the purpose of inspecting the same, regardless of whether such stock shall bear a certificate

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*The Rules and Regulations of the Crop Pest Commission are enacted and amended from time to time as occasion requires, in accordance with Act No. 6 of the Extra Session of the Louisiana Legislature, approved December 15, 1903, and said Rules and Regulations have the force of law. Violation of any Rule, Regulation or Order of the Crop Pest Commission is punishable by fine or imprisonment.

of inspection or not. The Entomologist shall have authority to seize, condemn and destroy any nursery stock infested with San Jose scale or other seriously injurious insect or disease, found within the confines of this State.

"(e) Each and every person, firm or corporation growing nursery stock for sale in this State shall apply to the Secretary of the Crop Pest Commission for inspection on or before July 1 of each year. It shall be the duty of the Secretary to inspect such nursery not later than November 1st. If upon such inspection the nursery stock and premises be found apparently free from the San Jose scale and other seriously injurious insects and plant diseases, a certificate shall be given to that effect. On and after August 1, 1905, a copy of said certificate bearing the seal of the Crop Pest Commission and the *fac-simile* signature of the Secretary, shall be attached to each and every box, bundle and package of nursery stock shipped within this State. Shipments of nursery stock not so labeled shall be refused for shipment by all common carriers and their agents, and such stock if found in transit or in the possession of any common carrier by the Entomologist or his assistants, shall be liable to confiscation.

"(f) No firm, person or corporation shall sell, give away, exchange or deliver, within this State, any trees, vines, shrubs, or plants, commonly known as nursery stock, without same having attached thereto in a prominent manner, a copy of the certificate of inspection signed by the Secretary of the State Crop Pest Commission, or by the State Entomologist or other duly authorized official of the State or country in which said nursery stock was grown.

"(g) The Entomologist of the Commission shall have power to require any one in the State to fumigate his trees, shrubs or plants with hydrocyanic acid gas or other substance, when, in his judgment, such treatment is necessary or advisable for the proper protection of the agricultural or horticultural interests of the State or of any section thereof."

Directions for Sending Insects for Identification.

The Entomologist of the Commission is at all times glad to render (always free of charge) every assistance possible in determining the identity of insects and plant diseases and advising measures for their control.

Do not send insects in envelopes or pasteboard boxes by mail; they are inevitably crushed beyond recognition. Send living insects in strong *wooden* or *tin* boxes by mail. No openings are necessary to admit air. Whenever possible enclose some of the foot-plant for the insects to subsist on while en route; specimens showing the injury done are desirable. *The name and address of sender should be on every package.* It is against the postal regulations to inclose a letter in a box by mail unless sent at letter postage rate. Specimens of caterpillars, worms, etc., in alcohol or other liquid can be sent by mail *only when in regular mailing tubes.* We will be greatly aided if correspondents writing about insect pests will give as full description of the habits, food-plants, injury and abundance as possible.

Specimens of twigs, living plants with foliage, etc., should be wrapped in damp (not wet) cotton cloth so as to reach us in fresh condition. Fruits showing injury or disease should be wrapped well with paper and packed in a wooden or tin box.

Correspondents can materially aid the work of this office by communicating with us regarding their success or failure in using the methods advised for controlling injurious insects and diseases, giving a careful detailed account of the methods used and the results obtained. Such information will prove of value to all.

CIRCULAR NO. 5

OF THE

State Crop Pest Commission

OF

LOUISIANA.

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BY

WILMON NEWELL.

ISSUED BY THE

STATE BOARD OF AGRICULTURE AND IMMIGRATION.

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State Crop Pest Commission of Louisiana.

ORGANIZATION

Hon. Newton C. Blanchard, Governor of Louisiana, Baton Rouge.

Hon. Chas. Schuler, Commissioner of Agriculture, Baton Rouge.

Prof. W. R. Dodson, Director of Louisiana Agricultural Experiment Stations, Baton Rouge.

Hon. L. S. Frierson, Frierson.

Hon. B. W. Marston, Eastpoint.

Wilmon Newell, Entomologist of Louisiana Agricultural Experiment Stations; Secretary and Entomologist of the Commission, Baton Rouge.

E. S. Hardy, J. B. Garrett, W. O. Martin, C. W. Flynn, Assistant Entomologists and Inspectors, Baton Rouge.

Miss L. E. Renneker, Clerk and Accountant, Baton Rouge.

State Crop Pest Commission

Of Louisiana.

CIRCULAR No. 5. January, 1906.

The Circulars of the State Crop Pest Commission are sent free of charge to all farmers and fruit growers of Louisiana who make application therefor.

THE WORK OF THE STATE CROP PEST COMMISSION WITH THE BOLL WEEVIL.

BY WILMON NEWELL.

It is universally recognized that any undertaking which requires for its complete success the co-operation of many individuals must be clearly appreciated and understood by all those whose interests are vitally concerned.

In its work of preventing the artificial dissemination of the boll weevil and in its attempts to mitigate the weevil damage in the territory already infested, the Crop Pest Commission has found no cause for complaint in the reception accorded its efforts by our citizens. At the same time, however, there are many who do not possess a clear understanding of the lines along which the Commission has inaugurated its campaign against this pest.

At present the boll weevil is not sufficiently abundant in more than one-thirtieth of the cotton-producing area of Louisiana for its destructiveness to be fully realized by the planters. Yet within a year, or within two years at most, the insect will have reached its maximum abundance in fully one-fifth of the cotton-growing area of the State.

To be concise, we are rapidly approaching the thick of the fight, the fight from which either the boll weevil or the Louisiana cotton planter will emerge victorious. At no time in the future will concerted action in waging a vigorous warfare against this enemy be of greater importance than during the coming two years.

Those farmers who adopt the proper methods of cotton culture will continue to produce profitable crops of cotton, while those who, either through ignorance or disinclination, fail to adopt those methods which years of study and practical experience have shown to be the only ones by which this foe can be successfully circumvented, will inevitably find one crop of cotton after another destroyed by the boll weevil.

To win this battle at the outset will mean increased prosperity, while to lose it will result in conditions little short of calamitous, alike to business man and farmer.

That the general adoption of the remedial measures, as embodied in the cultural remedy for the weevil, will ultimately prevail there can be no doubt, but if the Louisiana planter must learn by actual experience the necessity of adopting these measures it will mean, for him, the loss of several crops of cotton in rapid succession. That the farmers may be saved this costly experience is the earnest desire of the Commission, and realizing the importance of co-operation and of a thorough understanding between the Commission and the farmers as to the plan to be followed in the campaign against the boll weevil, it seems best to present a brief discussion of the lines along which the Commission's efforts are being directed.

The work of the Commission, in this campaign against the boll weevil, is being conducted along three rather distinct lines:

(1) Preventing, so far as possible, the spread of the boll weevil to new territory; (2) reducing the weevil damage in the territory already infested by disseminating information regarding the cultural methods to be employed in producing profitable crops of cotton in defiance of the weevil, and by experimental and demonstration work with the cultural methods upon different soils and under different conditions; (3) investigating, and disseminating information regarding, insects other than the boll weevil, in order that the production of crops other than cotton may be rendered more profitable than heretofore and the adoption of a diversified system of farming be encouraged among the farmers in the weevil-infested territory.

Before proceeding with a discussion of any one of these three lines of work, a short review of the weevil's progress into Louisiana territory up to the present time will be advisable in

order that the problems with which the Commission has had to deal may be more clearly understood.

The boll weevil first reached Louisiana in 1903. In all probability the 1903 infestation was by a migratory flight,* although some little evidence that the insect was introduced in other ways

FIG. 1.—Area in Louisiana infested by the boll weevil in December, 1903 (the small area shown in western part of Sabine Parish); and area infested in December, 1904 (total shaded area).

is not entirely wanting. The territory which was known to be infested in the fall of 1903 is shown upon the map in Figure 1, the infested area comprising a comparatively small area in the western portion of Sabine Parish.

*With exception of the outbreak discovered upon the grounds of the Louisiana Experiment Station at Audubon Park, New Orleans, in July, 1903, the weevils in this case having evidently been maliciously introduced. This outbreak was completely exterminated by the officials in charge of the Station.

No diminution of the infested area was noticeable as a result of the climatic conditions prevailing during the winter of 1903-04.

Acting upon the knowledge of the weevil's habits available at that time, the Commission undertook the complete extermination of the weevil in this limited area and undertook to prevent the spread of the insect by a rigid quarantine upon cotton seed, hulls and seed cotton, as well as upon household goods, hay, grain, sacks, baled cotton, etc., from the weevil-infested sections.

The extermination of the Sabine Parish colony was undertaken in the spring of 1904, by prohibiting the farmers in the affected territory from planting cotton, the land owners and tenants being paid a cash rental by the Commission and in addition being permitted to grow any crop other than cotton, that they desired.

Near Logansport an infestation covering a few acres, was found in the early summer of 1904, having evidently been there the autumn previous, but undetected. Extermination of this colony was accomplished by destruction of the cotton plants in the area involved and by systematic hand-picking of adult weevils and squares from trap-plants.

Early in August of 1904, the Special Field Agents of the Bureau of Entomology who were employed in Louisiana under the immediate personal supervision of Prof. H. A. Morgan, then Entomologist of the Crop Pest Commission, discovered boll weevils generally distributed in cotton fields where a few days before careful inspections had revealed none at all. Their numbers, as well as their occurrence in cotton fields several miles distant from the two original colonies, precluded all possibility of their being individuals which had escaped destruction at the time of extermination of these colonies. In all of the infested fields, Prof. Morgan and his assistants found only adult weevils, eggs and very young larvæ, showing that the arrival of the adult weevils in fields many miles apart had been practically simultaneous.

Only one explanation of this phenomenon presented itself, and that was that these weevils had migrated from the infested cotton fields of Texas. Further examinations of cotton fields during the summer and autumn months of 1904, by Prof. Morgan and the Special Field Agents of the Bureau of Entomology, es-

tablished the existence of a marked and clearly defined migratory movement of the weevil into new territory. This migratory habit of the weevil, which had previously been unknown and evidently unsuspicioned—as it is not mentioned in any of the writings on this insect prior to that time—entirely revolutionized the methods to be employed in retarding its progress into new territory.

While the eradication of the colony at Logansport, as well as the extermination of the Audubon Park outbreak the previous year, demonstrated conclusively the possibility and practicability of exterminating *isolated* sporadic outbreaks of the weevil, the discovery of the migratory habit of the weevil showed the eradication of infestations *in the territory covered by the yearly migrations* to be not only impracticable, but impossible, as fields in which the cotton might be destroyed in the work of exterminating the insect would become reinfested from surrounding territory with the coming of the following year's migration. The discovery of this migratory movement upon the part of the weevil, by Prof. Morgan and his assistants at this time, of itself resulted in the saving of many thousands of dollars to the State of Louisiana. Had the attempt been made to exterminate the weevil in all of the territory entered by it in 1904, many thousands of dollars would have been expended in vain. In addition to this, the discovery of the migrations showed that the very rigid quarantine upon a great variety of articles, which had previously been enforced to the extent of causing serious inconvenience and loss to business interests, was of insufficient avail to justify its continuation, and a quarantine system working no hardship but proving eminently more successful, was substituted.

The migratory movement of 1904, while most marked and extensive during the latter part of August, continued with greater or less volume until frost, the weevil's movements during the latter part of the season being more or less continuous and hardly distinguishable as distinct migrations. The territory gained by the weevil during the month of August more than equaled in area all of the territory gained by it during September, October and November. The area infested by the weevil in December, 1904, is seen in Figure 1.

The winter of 1904-05 was one of the most severe that Louisiana has seen for many years, the temperature being much

lower than usual and the rainfall much in excess of normal for the winter months.

Careful examinations in cotton fields aggregating several thousand acres, between May 1 and August 1, 1905, showed that the weevil had not survived the winter in the eastern portion of the territory infested the previous autumn. In other words, the weevils were exterminated by meteorological conditions in that area which they did not occupy until after about the middle of September, 1904, and in which, therefore, they did not have opportunity to breed up to considerable numbers before the arrival of frost. The territory infested in July, 1905, is shown by Figure

FIG. 2.—Area in Louisiana infested by the boll weevil in July, 1905.

2, and by comparison with the eastern limit of infestation in December, 1904 (Figure 1), an idea will be had of the amount

of territory actually lost by the insect. It is, of course, conceivable that an occasional weevil might have survived the winter in this territory, but the examination of so many cotton fields in different localities, and with different surroundings, by men thoroughly skilled and practiced in detecting even the lightest infestations, and each of whom was in ignorance of the findings of the rest, seems to reduce the chance of any survivals in this area, to one in many thousand.

Perhaps the most interesting point noticed in connection with this extermination of the weevil by meteorological conditions, was the fact that it was exterminated in Caddo, the northernmost parish in the State, and also at Cameron, the southernmost point at which the weevil has been found in Louisiana. As Cameron has the highest average winter temperature of any locality in Western Louisiana, and as Caddo Parish has very nearly the lowest average winter temperature of any locality in the State, it appears that the excessive moisture rather than low temperature, was responsible for this heavy mortality.

A similar loss of territory by the weevil in Northern Texas was noted by Prof. Hunter and his assitsants, and so far as the writer is aware the winter of 1904-05 was the first in which meteorological conditions brought about such a great decrease in the territory infested by this insect.

In 1905, the migratory movement of the weevil commenced about the middle of August and continued with more or less continuity until about November 20. The existence of certain quarantines throughout the State during August, September and early October, on account of yellow fever, prevented the extensive field observations necessary to determine the exact time and extent of the migratory movements. Field work could not be resumed until the middle of October, and after that date an accurate survey was made to determine the eastern limit of the territory invaded.

The migrations of 1905 gained for the boll weevil, practically all of the territory it lost during the winter and a very considerable area in addition. Cameron, Louisiana, a community practically isolated from other cotton-growing sections by many miles of marsh, was the only locality not re-infested by the 1905

migrations, careful field examinations in this locality during December failing to reveal any indication of infestations.

FIG. 3.—Area in Louisiana infested by the boll weevil in December, 1905.

In the eastern part of the area at present infested (Figure 3) the infestation of course is exceedingly light, maximum infestation and consequent severe injury not occurring before the second season of infestation and occasionally not before the third. In those portions of the State reached by the weevil in the fall of 1903 or the very early summer of 1904 the injury during the season just passed has been considerable. Roughly outlined, the area suffering severest weevil injury during 1905 is embraced in Western Vernon and Sabine Parishes and Southwestern DeSoto Parish. In Western Sabine Parish the weevils are doubtless as abundant as they ever will be, and it is interesting to note, incidentally, that the farmers in this section who have fol-

lowed the cultural measures advocated by the Crop Pest Commission and the Bureau of Entomology have made approximately 90 per cent. more cotton per acre than those who adhered to the use of big-boll, late-maturing varieties and to indifferent and insufficient cultivation.

I.—THE QUARANTINE MAINTAINED BY THE CROP PEST COMMISSION.

By virtue of the provisions of Act No. 6 of the Extra Session of the Louisiana Legislature of 1903, the Crop Pest Commission is vested with authority to make and enforce quarantine regulations governing the movement of any material likely to disseminate the boll weevil or other seriously injurious insect.

The quarantine at present maintained by the Commission, in connection with the boll weevil campaign, prohibits the movement of cotton seed, seed-cotton, cotton-seed hulls, cotton-seed sacks (used) and seed-cotton sacks (used) from the infested territory of Texas and Louisiana to any point in the non-infested sections of Louisiana.

The materials mentioned are those which experience has shown to be such as are most likely to contain living boll weevils, and the shipment of which to uninfested sections might therefore result in new infestations many miles ahead of the gradually-advancing line of weevil-infestation. Of the materials named, only one, cotton seed hulls, is ever permitted shipped into the uninfested territory under any circumstances. The Commission has perfected a method by which cotton seed oil mills can so arrange their machinery as to handle the hulls after they leave the huller in a manner that will effectually prevent the dissemination of boll weevils with them, and to mills having a satisfactory arrangement of their machinery as required by the Commission, permits are given for the shipment of cotton-seed hulls to any point in the non-infested section.

The Commission is frequently confronted with the question: "So long as the weevil's progress by migratory flights cannot be controlled, what is the use of trying to maintain a quarantine upon shipments likely to disseminate the weevil?" To any thinking man who will note the progress made by the weevil each year in its migrations, and the loss of territory which the pest experienced last winter (see Figures 1 and 2), the answer

must be evident. Even though the insect is each year gaining additional territory and even though ultimate infestation of the entire cotton belt appears inevitable, much is to be gained by preventing the pest obtaining a foothold many miles ahead of the gradually-advancing frontier of infestation. For example, if infestations now occurred in the north central portion of Louisiana and at points along the Mississippi River, as well as in that portion of the State east of the river, it is evident that the entire State would become infested much sooner than if all such outbreaks were prevented and the weevil forced to limit its progress into new territory to actual bodily movement.

Even if the gradual advance of the pest cannot be permanently prevented, there is certainly no justification for permitting it to be accelerated. To abandon quarantine measures simply because the weevil gains new territory each year by flight, would be analagous to the case of a large city in which a conflagration occurs, spreading gradually, and in which on that account the authorities permit other fires to be started in other portions of the city, each of which in turn would itself become a conflagration involving a large area.

It is pleasing to note that not a single case of infestation by the boll weevil is known to occur east of the territory which has been occupied by the weevil in its migrations, the eastern limit of which is virtually coincident with the quarantine line established by the Commission, and we have therefore every reason to believe that this quarantine has been entirely successful and has thereby saved not only Eastern Louisiana, but States east of us, from infestation through shipments of the articles referred to above. There is at least no evidence to indicate that the enforcement of these quarantines by the Commission has not accomplished as much in restricting the spread of the boll weevil as could be accomplished by any agency subject to human control.

That the boll weevil has not appeared at any point east of the territory gained by the migrations has been construed by some as evidence that the weevil is never transported in cotton seed, hulls, etc. No conclusion could be more erroneously drawn, for the observations made upon the spread of this insect in Texas, where no such quarantines were enforced, as well as the data obtained in connection with the hibernating habits of the weevil

and the examination of cotton seed from heavily infested sections, expose prominently the danger of dissemination in shipments of such materials. By preventing the shipment of those materials most likely to disseminate the weevil the Commission has prevented the possibility of sporadic infestations in the present uninfested portion of the State.

II.—THE CAMPAIGN AGAINST THE BOLL WEEVIL IN THE TERRITORY ALREADY INFESTED.

In the territory which is already infested by the boll weevil, the Commission has exerted every effort to furnish all planters and farmers with accurate and detailed information regarding those farming methods which must be employed to produce profitable crops of cotton in spite of the weevil. The Commission advocates, essentially, the cultural methods perfected by Dr. L. O. Howard and Prof. W. D. Hunter of the Bureau of Entomology. The dissemination of this information has been through the press, by means of bulletins and circulars, by addresses at farmers' meetings, by the co-operation of local business men in the distribution of literature and by actual field demonstrations in growing cotton in the heavily infested sections under the directions of the Assistant Entomologists in the employ of the Commission. In addition to this work, the Commission has conducted rather elaborate experiments in determining the value of the different steps involved in the "cultural remedy," as well as along kindred lines.

As Paris green has at times been enthusiastically advocated as a sovereign boll weevil remedy, the Commission undertook during the season just passed, exhaustive experiments in determining the value of this agent in the campaign against the weevil. The results were somewhat surprising, as they showed that not only was the boll weevil not destroyed by applications as heavy as could be made without destroying the foliage of the cotton plants, but that the application of Paris green in late summer, by killing the cotton caterpillar, indirectly increased the food supply of the weevils, facilitating breeding and furnishing an abundance of food, in the form of squares and young bolls, right up to the time of entering hibernation, thereby greatly increasing their chances for successful survival of the winter.

A "hibernation experiment" with the boll weevil, at present under way, is perhaps the largest experiment that has ever been undertaken in "breeding cages." In the neighborhood of 30,000 adult boll weevils are being used in the experiment, distributed among 18 cages, each of which occupies 160 square feet of ground and has a height of about 8 feet. These cages contain hibernating quarters, offering varying degrees of protection from rain and cold, simulating as near as possible the different conditions which obtain upon the average Louisiana plantation.

The object of the experiment is, of course, to determine the per cent of weevils which survive under different conditions for hibernation and when forced to subsist for varying intervals without food before entering hibernating quarters in the fall. In addition to this, we expect to determine next spring, the date and temperature at which the first hibernating adults emerge from winter quarters, the time at which the bulk of hibernated weevils emerge and the date at which the last individuals leave hibernation. An accurate knowledge of all the points involved is of the utmost importance in securing the maximum results in employing the cultural remedy.

The experience of past years with various injurious insects in this and other countries has shown that successful remedies for insect pests cannot be devised or applied, except in rare instances, without accurate knowledge of an insect's habits and different stages of development being first obtained. In the case of the boll weevil, this necessary knowledge is already at hand for its habits and periods of development, at different seasons of the year, have been carefully studied, not only by the entomologists of the United States Department of Agriculture, but also by the entomologists employed for the purpose in Mexico, Texas and Louisiana. All of this accumulated knowledge concerning the insect shows conclusively that the only successful and practical remedy for the boll weevil is the cultural remedy, including the use of quick-maturing varieties of cotton, early planting, thorough cultivation, and especially the early fall destruction of the cotton plants, this latter measure actually destroying the bulk of the weevils.

The "boll weevil problem" is very similar to many other insect problems which in the beginning appeared almost impossible

of solution but which, after careful study and investigation by entomologists, have been solved satisfactorily and effective means of control devised which have resulted in the saving of hundreds of thousands of dollars to the farmers interested.

Prolonged investigation of the cotton boll-worm (an insect entirely distinct from the boll weevil) has given us a thorough knowledge of its habits and development, and this knowledge has indicated the proper cultural measures to be employed against it, with the result that many progressive cotton planters now suffer a loss of less than 5 per cent of their crop, whereas before the adoption of these measures their loss was from 20 to 30 per cent, and even as high as 40 per cent. This saving has been accomplished without any increase in the cost of making the crop.

The Hessian-fly, which in former years destroyed from 20 to 90 per cent of the winter wheat crop in various parts of the winter wheat belt, can now be controlled completely by cultural measures which do not involve any extra expense in the production of the crop. Prof. F. M. Webster, upon a careful study of this insect, found that the adult fly emerged at almost the same date each year to deposit eggs upon the young wheat plants, and that the amount of rainfall for a few weeks preceding, either retarded or accelerated the development of the adult flies, so that, the rainfall being known, the time of appearance of the flies could be accurately forecasted. By delaying for a few days the sowing of his wheat in the fall, the farmer can prevent entirely the damage from this insect, for the females cannot deposit their eggs upon wheat plants that do not come up until after the adult flies have died of starvation. The farmers in the winter wheat sections were quick to see the enormous benefits to be derived from this simple measure, and at present the wheat-growers of Ohio, Kentucky and adjacent States are no longer compelled to pay heavy toll to this insect.

The San Jose scale,* which for a few years threatened to make the growing of peaches, plums and apples an impossibility in the United States, was a far greater terror to the fruit growers than is the boll weevil to the Louisiana cotton planter at present, yet by the patient and careful investigations of various State

*The San Jose scale is discussed, and remedies for it given, in Circular No. 4 of the Crop Pest Commission, which will be sent to any farmer upon request.

Entomologists economical and effective means of control were developed. Thousands of fruit growers who have this pest upon their premises now keep it fully under control, and are producing as profitable crops of fruit as were ever produced before this pest was introduced. In fact, the entire peach-growing industry of Georgia owes its very existence to the fact that Prof. W. M. Scott, the first State Entomologist of that State, demonstrated that the lime-sulphur washes would effectively and cheaply hold this enemy in check. The annual peach crop of Georgia ranges in value from $500,000 to $1,000,000, and is constantly increasing. This very considerable addition to the wealth of that State is thus the result of the work done by entomologists upon one single injurious insect.

Space cannot be taken here to refer even briefly to the success which has followed the application of the remedial measures devised and advocated by entomologists and other scientists for insects and plant diseases—how the grape-pylloxera, an American insect introduced into Southern Europe many years ago, caused enormous damage and threatened to destroy the immense vine industries of France and other European countries, and how its control was ultimately accomplished by simple measures, how the destructive grasshoppers of the North are now destroyed by the "Criddle mixture", how the chinch-bugs of the Central Mississippi Valley States are often destroyed by a contagious disease artificially distributed among them, how the orange-growing industry of California was saved by an entomologist bringing a lady bird beetle from a foreign country to destroy the cottony cushion-scale, etc.

In the cultural remedy for the boll weevil we have the means of avoiding the bulk of the threatened damage by this pest, and it now remains for the cotton planter in the weevil-infested section to put these cultural measures into operation and meet with the success which farmers elsewhere have attained by applying the remedial steps advocated by entomologists for other insect pests.

It may not be out of place to remark, in this connection, that were the farmers in the infested section to *universally* practice the early fall destruction of the cotton plants, there would in all probability come a season sooner or later when climatic and

meteorological conditions, in combination with the early fall destruction of the plants, would bring about a *complete extermination* of the boll weevil. The experiment made by the Commission, referred to in Circular No. 3, in which boll weevils were taken Oct. 16, 1905, from a cotton field in DeSoto Parish and kept under outdoor conditions, but without being given any squares, leaves or bolls to feed upon, points very strongly towards the possibility of such an extermination. Although the weevils in this experiment were furnished with all the water they desired, all of them died before Nov. 28th, and yet in the same locality the weevils in the fields, with food, showed no tendency whatever to seek hibernating quarters before Dec. 8th.

The writer fully believes that had all the cotton plants in DeSoto Parish been destroyed by Oct. 16, the first day of January (1906) would not have seen a single living boll weevil in that Parish. The very *least* that can be said is that, where the plants were allowed to stand until heavy frost, there will be at least a thousand weevils next spring to attack the young cotton where there would be but one had the plants all been destroyed by the middle of October, or even as late as the middle of November.

Even if the fall destruction of the cotton plants did not directly result in the production of a single pound more of lint the following season, it would abundantly pay the farmer to destroy every cotton plant, early every fall for ten years, in order to secure the enormous benefits following the season in which by the coincident effect of a "late fall" and a severe, wet winter, combined with the effect of the early fall destruction of the cotton plants by the farmer, the weevils would be completely exterminated.

III.—THE INDIRECT METHOD OF REDUCING BOLL WEEVIL DAMAGE.

That the boll weevil has no food-plant other than cotton has been firmly established. The farmer who produces crops other than cotton has nothing to fear from boll weevil ravages, but unfortunately he finds other insect enemies threatening his success regardless of what crop he may undertake to substitute for cotton. The Crop Pest Commission does not overlook the fact that we are to continue in the future, as in the past, to produce cotton, but under the present labor and credit systems which pre-

vail in Louisiana, the profitable production of cotton, *upon as large a scale* as formerly, with the weevil present, will be impossible and the growing of cotton to the practical exclusion of other crops must be succeeded by a diversified system of agriculture. By the control of insects seriously injurious to crops other than cotton, and by disseminating information concerning methods of successfully combating them, the profits derived from producing such crops are materially increased and the advent of a properly diversified system of farming is accordingly hastened.

As illustrating the work being done along this line, we may call attention to the fact that during 1905, for the first time, Louisiana had a thorough inspection of all her fruit tree nurseries, with the elimination of dangerous insects and diseases from them, so that the fruit growers who now purchase fruit trees from Louisiana nurseries obtain trees that are healthy, instead of trees frequently infested with insects which cause their complete destruction within three or four years after they are planted out.

The entrance of dangerous insects and diseases of fruits from without the State is guarded against by the Commission enforcing quarantine regulations on shipments of nursery stock into Louisiana from other States or countries.

Although the Commission has done but one year's work along this particular line, it has already prevented the dissemination of sufficient San Jose scale to infest all the orchards and ornamental grounds of the State.

The climate and soils of Louisiana are peculiarly adapted to fruit production and that fruit growing may be encouraged, and in some degree supplant the less profitable cotton production, the Commission is inaugurating an active campaign against the San Jose scale, undoubtedly the worst insect enemy with which the fruit growers have had to contend.

Louisiana conditions are likewise exceedingly favorable for the production of live stock, the greatest drawbacks to success being the Texas fever cattle tick and, in some sections of the State, the horse-flies and deer-flies.

The valuable work done by Prof. Morgan, former Entomologist of the Commission, in studying the life history and development of the cattle tick and in devising a successful method

of eradicating this pest from farms and plantations is well known. The Commission is at present continuing the cattle tick investigation, obtaining additional facts concerning the tick's development in different sections and under varying conditions, in order that the methods of eradication may be even more clearly understood and practiced.

An investigation of the horse-flies in Southern Louisiana has been under way for some time, the Commission having secured in this work the assistance of one of the best known authorities upon this group of insects in the United States. The problems presented in connection with the development of the different species are exceedingly difficult of solution, and while several years of study will be required before fully satisfactory means of control can be devised, the facts already obtained are of considerable economic value and will be given in a circular now being prepared for publication.

Investigations of other insect pests, which cause in the aggregate losses of many thousands of dollars annually in Louisiana, are being made. It is, however, sufficient in this connection to call attention to the fact that as the territory infested by the boll weevil increases, and as the present infested area approaches a state of maximum infestation, the warfare against all of these destructive insects will become of much greater moment to the agriculture of the State than at present.

The State Crop Pest Commission is still in its infancy, and dealing as it is with a problem differing in many respects from any that has ever confronted any similar organization, some little time has necessarily been employed in perfecting methods of work, in obtaining properly equipped and trained employees, in organization of the work, in securing the co-operation of citizens and in conducting investigations upon which to base future operations.

Each year will see a material increase in our knowledge of the pests which have been feasting upon the farmers' profits, and all of this knowledge will ultimately be applicable in the devising of remedies for these enemies.

Directions For Sending Insects for Identification.

The Entomologist of the Commission is at all times glad to render (always free of charge) every assistance possible in determining the identity of insects and plant diseases and advising measures for their control.

Do not send insects in envelopes or pasteboard boxes by mail; they are inevitably crushed beyond recognition. Send living insects in strong *wooden* or *tin* boxes by mail. No openings are necessary to admit air. Whenever possible enclose some of the food-plant for the insects to subsist on while en route; specimens showing the injury done are desirable. *The name and address of sender should be on every package.* It is against the postal regulations to inclose a letter in a box by mail unless sent at letter postage rate. Specimens of caterpillars, worms, etc., in alcohol or other liquid can be sent by mail *only when in regular mailing tubes.* We will be greatly aided if correspondents writing about insect pests will give as full description of the habits, food-plants, injury and abundance as possible.

Specimens of twigs, living plants with foliage, etc., should be wrapped in damp (not wet) cotton cloth so as to reach us in fresh condition. Fruits showing injury or disease should be wrapped well with paper and packed in a wooden or tin box.

Correspondents can materially aid the work of this office by communicating with us concerning their success or failure in using the methods advised for controlling injurious insects and diseases, giving a careful detailed account of the methods used and the results obtained. Such information will prove of value to all.

CIRCULAR NO. 6

OF THE

State Crop Pest Commission

OF

LOUISIANA.

A Preliminary Report on the Horseflies of Louisiana With a Discussion of Remedies and Natural Enemies,

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BY

JAMES S. HINE.

ISSUED UNDER THE DIRECTION OF THE

STATE BOARD OF AGRICULTURE AND IMMIGRATION.

CHAS. SCHULER, Commissioner.

BATON ROUGE:
THE TIMES, OFFICIAL JOURNAL OF LOUISIANA.
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ERRATA.

CIRCULAR NO. 6, STATE CROP PEST COMMISSION OF LOUISIANA.

On page 32, footnote, first line, read: "2 pounds of whale oil soap," instead of: "2 pounds of whole oil soap."

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State Crop Pest Commission of Louisiana.

ORGANIZATION.

HON. NEWTON C. BLANCHARD, Governor of Louisiana, Baton Rouge.

HON. CHAS. SCHULER, Commissioner of Agriculture, Baton Rouge.

PROF. W. R. DODSON, Director of Louisiana Agricultural Experiment Stations, Baton Rouge.

HON. L. S. FRIERSON, Frierson.

HON. B. W. MARSTON, Eastpoint.

WILMON NEWELL, Entomologist of Louisiana Agricultural Experiment Stations; Secretary and Entomologist of the Commission, Baton Rouge.

J. B. GARRETT, C. W. FLYNN, E. C. COTTON, HARPER DEAN, JR., Assistant Entomologists and Inspectors, Baton Rouge.

MISS L. E. RENNEKER, Clerk and Accountant, Baton Rouge.

INTRODUCTION.

Among the many injurious insects with which the farmers and planters of Louisiana have to contend, few are of more importance than the insects known as horseflies, deerflies and earflies. All of these flies, belonging to the group of insects known to entomologists as the Tabanidæ, at times reach enormous numbers in parts of Louisiana. In fact, it is doubtful if any of the scientists who have touched, in their publications, upon the importance of these insects, or upon their role in the dissemination of disease, have had even a remote conception of the enormous numbers of these flies which at times infest certain of the coast and alluvial sections of Louisiana.

Aside from their direct damage in reducing the flesh of the animals attacked and in preventing the growth of young stock, these flies are instrumental in the dissemination of anthrax, or charbon, a disease which has from time to time during the past one hundred years or more, ravaged the herds of Louisiana and stood as an almost insurmountable barrier to the successful and profitable production of beef and dairy cattle, which the climate and abundant forage of the State would otherwise make possible.

While charbon outbreaks usually originate by an animal obtaining, while grazing on infected pastures or headlands, the spores of the disease, its further dissemination to plantation feed lots and stables is almost entirely through the agency of these flies, which, after feeding upon either the diseased live animal or upon the cadaver, fly to animals throughout the entire neighborhood, carrying with them the anthrax spores and bacilli.

Could the horseflies be exterminated in any given locality, or even considerably reduced in numbers, the control of this disease and its ultimate eradication would be rendered much easier than at present.

The first step looking to the successful control or eradication of any insect must be the acquisition of a thorough knowledge regarding its life history and development. The develop-

ment of the horseflies (and other flies of the same family) is somewhat complicated, and the determination of the various stages requires long and tedious study and observation.

Despite the great economic importance of this group, but little is known regarding the various species and regarding means by which they may be controlled.

Perhaps the most valuable acquisitions to our knowledge of these insects during recent years have been those resulting from the investigations by Prof. James S. Hine, of the Ohio State University. Mr. Hine has made a special study of them in different States for several years past, and has not only described many forms hitherto unknown, but has successfully worked out the life histories of a considerable number of species.

As a preliminary step towards finding suitable measures for reducing the numbers of these insects, the State Crop Pest Commission, in co-operation with the Gulf Biologic Station, secured the services of Mr. Hine during the summer of 1905 in making a study of the horseflies of Louisiana.

The results of Mr. Hine's work are given in this paper, which is being published concurrently as Bulletin No. 5 of the Gulf Biologic Station of Louisiana, under the direction of Director B. H. Guilbeau.

WILMON NEWELL,

Secretary, State Crop Pest Commission of Louisiana.

Baton Rouge, La., Feb. 15, 1906.

PREFACE.

This paper is my report to the State Crop Pest Commission and Gulf Biologic Station of Louisiana, by whom I was employed during a part of the summer of 1905. During most of my stay in the State I was located at the Gulf Biologic Station, on the gulf coast, about thirty miles from the Texas State line. Mr. Wilmon Newell, Secretary of the Crop Pest Commission, and Prof. B. H. Guilbeau, Director of the Gulf Biologic Station, showed me every consideration, and it was on account of their interest and suggestions that the work was undertaken. I desire to express my appreciation, not only for what these two gentlemen have done, but also for what many of their associates have done to aid the progress of this work.

The drawings, with the exception of those of *Chrysops* and those otherwise accredited, were made by Miss Lumina C. Riddle, of Columbus, Ohio.

JAMES S. HINE.

Columbus, Ohio, February 1, 1906.

State Crop Pest Commission

OF LOUISIANA.

CIRCULAR NO. 6. FEBRUARY, 1906.

The Circulars of the State Crop Pest Commission are sent free of charge to all farmers and fruit growers of Louisiana who make application therefor.

A Preliminary Report on the Horseflies of Louisiana, With a Discussion of Remedies and Natural Enemies.

BY JAMES S. HINE.

A paper on the horseflies of the State of Louisiana at the present time must necessarily be incomplete, as only a little time, comparatively speaking, has been put on the subject, and, what is more, the various species wherever found are difficult to make observations upon since the flies in all stages are rather retiring in their habits. The life of the larva is passed in the water or in the ground, and the pupa is difficult to find, and, moreover, when the adult appears it flies so rapidly, and most of the time in such secluded places, that it is seldom seen except when it alights on animals for the purpose of biting in order to procure food. Then again, the life cycle often occupies

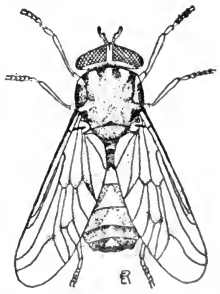

FIG. 1.—Autumn horsefly *(Tabanus sulcifrons)*, female, natural size.

a whole year, and sometimes more; and as even an approach to the conditions of the natural habitat and food of the larva is difficult to attain and perpetuate for any length of time by artificial means, the rearing of the various species under observation can not be otherwise than a very tedious undertaking.

Various common names, such as horseflies, gadflies, deerflies, dogflies, earflies and woodflies,* are applied to these insects in different sections of the country. They belong to a single family called Tabanidæ, and all of them are of medium to large size, with wings either transparent or clouded, or spotted with black or brown.

They are of especial interest to the economic entomologist, the farmer and the stock raiser on account of their blood-sucking propensities and the injury and annoyance they cause to domesticated animals on account of this habit. Not only are horses attacked, but cattle, hogs and sheep as well, although the latter are more or less protected by their wool, which to some extent acts as a blanket over most of their bodies.

All through the group the males and females are easily distinguished from one another by the eyes, which in the male sex are united on the front of the head, while in the female sex there is a rather narrow space on the front of the head separating the eyes from one another. It is worth while to be able to tell the sexes apart, for, like the mosquitoes, it is only the females that suck blood, or, in other words, that are troublesome to stock. The males, and, under certain circumstances, the females also, live on the nectar of flowers or the juices of plants, or on other sweet liquid or semi-liquid substances.

These flies are usually troublesome only when the sun is shining, or at least after eight o'clock in the morning. They rest on foliage or trunks of trees, on posts, stumps, fences or in other inconspicuous places during the night and early morning hours, and then come forth in myriads as soon as the sun warms the atmosphere, to get a meal of blood from any animal that comes in their way; and it seems that the hotter the sun the more active they are, and the more injury and annoyance they cause to farm animals.

*According to Mr. Harper Dean, Jr., the term "Mayflies" is applied in parts of Virginia to certain species of *Chrysops*.

All the species of horseflies taken so far in Louisiana belong to two genera, *Chrysops* and *Tabanus*. In *Chrysops* ("earflies" and "deerflies") the wings are variegated with black, and the various species are only slightly larger than the common housefly; in *Tabanus* ("horseflies") the wings are hyaline, or generally marked with small black or brown spots, and the species are larger, some of them very large. One or two of the

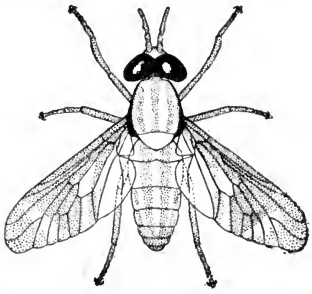

FIG. 2.—Little earfly *(Chrysops pikei)*, male, enlarged to three diameters.

large species have the wings nearly uniformly black all over, and another smaller one has the wings distinctly variegated with black. There is no doubt but that there are two or more other genera in the State that have not been collected, but the ones named above, in any case, include most of the species especially injurious in the United States.

EGGS AND EGG-LAYING IN GENERAL.

All the species of *Chrysops* whose egg-laying habits I know, and many species of *Tabanus* as well, place their eggs over water, while other species of *Tabanus* oviposit on plants standing in wet ground. Some species are very precise in placing their eggs Thus, *Tabanus stygius*, which I have observed many times follows the interesting habit of ovipositing on the upper surface of the leaves of the arrow plant,* placing the eggs just above the point where the petiole meets the expanded part of the leaf. So closely is this habit followed that a hundred masses of eggs are found thus located to one placed otherwise. Sometimes a mass is observed on the leaf of another plant, but in the same location, and once in a long time eggs are seen in a different position on a leaf.

Sagittaria sp.

The black horsefly* is very apt to place its large mass of eggs, containing upwards of 500, in a certain position on a particular species of sedge in low ground near swamps and ponds.

The rather small horsefly known as *Chrysops callidus* arranges her eggs in a single layer on leaves of various kinds of plants overhanging the water of ponds and small lakes.

Chrysops moerens oviposits much like the last, except that the eggs are placed over deeper water. It is not rare to find

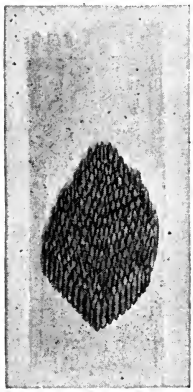

FIG. 3.—Eggs of an earfly, *Chrysops moerens*, enlarged. (After Hart, Bull. Ills. State Lab., Volume IV.)

these eggs on giant sedges standing in four or five feet of water.

The eggs when first laid are white in the case of all species thus far observed, but gradually get darker until they become brown or black. The eggs of the various species of *Chrysops* are usually shining black, while those of *Tabanus* are more often clear brown. Thus we see that since the eggs of horseflies are laid on a green surface they form a striking contrast with their surroundings.

It is well known that in some of the flesh-flies or scavengers, the eggs are either hatched, or nearly ready to hatch, when deposition takes place. Not so with eggs of the horseflies, for these do not show any apparent development when first laid; and as about seven days are required for them to hatch under favorable conditions, we are safe in concluding that incubation has not advanced far at the time of laying. It is very interesting to watch a brood of these minute larvae leave the eggs, for

*Tabanus atratus.

they nearly all hatch together, and at one minute a wriggling mass is seen obscuring the egg shells from view, while at the next the hundreds of miniature horseflies loosen their hold on the leaf that supported them and go tumbling down into the water, where they separate, and each henceforth looks after its own affairs. What goes on from this point is more or less vague, but it may be guessed that not all of the individuals from a single mass of eggs ever live to become adults, for there are plenty of animals, large and small, in the water that must find a living, and the horsefly larvae no doubt constitute a fair portion of the food for some of these forms.

THE LARVAE OF HORSEFLIES.

The larvae after hatching from the eggs, as referred to above, grow slowly, feeding on animal life of various kinds, until at the end of several months they become full grown and ready to enter the pupal stage.

FIG. 4.—Larva of the black horsefly (*Tabanus atratus*), enlarged. (After Hart, Bull. Ills. St. Lab., Volume IV.)

The larvæ of the different members of the family are very much alike in appearance, but vary somewhat in color and size, and it is often difficult to distinguish the full-grown larvæ of small species from the young larvæ of the larger species.

When first hatched it appears to be the desire of the larvæ to burrow, consequently, if they are not permitted to get to the mud, they crawl into particles of decaying plants, or anything that may be at hand. The immature stages of many species probably remain in the water, or in the mud very near the edge of the water, during their whole existence as such. The pupæ come to the surface of the ground a few inches from the edge of the water just before the adults issue, and around fresh water ponds at the proper season one may see myriads of pupa-skins of certain species with only their anterior ends projecting above the surface of the ground.

Information at hand indicates that there is a wide variation in the habits of various species, for besides finding the larvæ in water and in mud close to water, they are found oftentimes in dry ground long distances from water. Although very young larvæ do not take kindly to artificial conditions, older specimens are easily kept in breeding cages, and in all cases observed, live as well in ground slightly moist as they do in mud. They eat small soft-bodied invertebrate animals of many kinds, not excluding members of their own family, or even of their own species. In artificial rearing of these insects small earthworms seem to answer well as food for the larvæ.

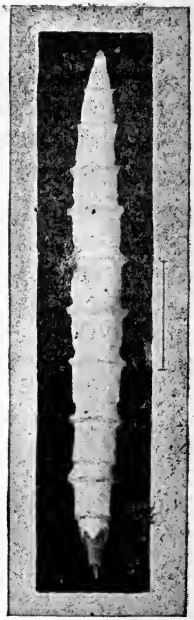

FIG. 5.—Larva of the striped earfly (*Chrysops vittatus*), enlarged. (After Hart, Bull. Ills. St. Lab., Volume IV.)

It is always necessary to keep each specimen in a separate dish or breeding cage, for if two are placed together one is almost sure to devour the other in course of time. One hardly ever fails to obtain the adult fly if older larvæ are taken and proper attention given.

THE PUPA.

The pupae in all species I have seen are dull yellowish in coloration, with an encircling row of spines or stiff hairs at the apical third of each abdominal segment. This stage is also much the same in appearance in the different species, but there is a striking difference in size, and this is of more consequence in the pupa than in the larva, for in the larva difference in size may indicate different ages of the same species as well as different species, while difference in size of the pupa may be taken to indicate different species only.

Characters for distinguishing the pupæ of different species are found in the external breathing organs, or spiracles, and in the teeth-like appendages located at the apex of the abdomen.

If one attempts to find pupæ of horseflies, he is not usually successful, for it is not certain that they will be found in any particular place any more than in some other place. On account of the hairs and spines with which they are clothed, the soil sticks to them more or less, causing them to have the same general color as the ground in which they occur, so that they are very easily overlooked.

FIG. 6.—Pupa of the lined horsefly *(Tabanus lineola)*, enlarged. (After Hart, Bull. Ills. St. Lab., Volume IV.)

ON THE LIFE HISTORY OF THE STRIPED EARFLY.

(Chrysops vittatus Wiedemann.)

This is a common species in Louisiana, for which reason its life history may be properly considered in this paper. Personally, I have not worked out the life history of this particular species fully, so it seems best to quote as follows from Hart's paper "On the Entomology of the Illinois River and Adjacent Waters," published in Volume IV of the Bulletin of the Illinois State Laboratory of Natural History, Page 228:

"The larvae were found in connection with other larvae in a weedy and swampy brook. They were quite common, occurring in the mud and the mats of dead stems, and rarely floating at the surface. The first were seen March 28, but they continued to occur up to April 15, increasing slightly in size. In the breeding cage they burrowed into the mud and vegetation. In the latter part of May the water was allowed to dry up, and on the 28th, all that remained was poured off. June 1 to 3, three pupae were formed in the damp mass of dead vegetable matter resting on the mud in the cage. Two imagoes emerged June 9, both males, the third failing to transform. The coloration of the larva readily distinguishes it.

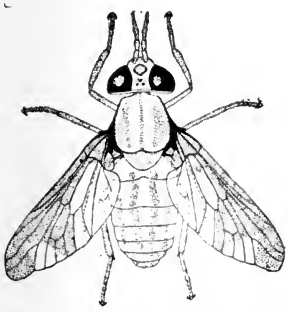

FIG. 7.—Striped earfly *(Chrysops vittatus,)* female, enlarged to three diameters.

Length of larva, 10 to 15 millimeters, diameter 1.6 millimeters. Head light-colored, mouth parts pale, tips of maxillary palpi in line with the end of the labrum; body whitish, a mottled appearance within at middle of body.

Dorsal and ventral areas striate, striae entire, distinct, and not very fine; lateral striation a little finer, that of the prothorax very fine, with a small smooth spot adjoining the smoother surface of its ventral area; latter shorter than dorsal, not including anterior pair of setae, medium sulcus scarcely dull pubescent. Meso- and metathorax with lateral impressed lines, and dull pubescent pale annuli, but the lateral lines almost without pubescence. Fleshy false feet of abdominals rather prominent, dorsal pair united into one, there being no narrowing near the median line; annuli very pale, except on the last two or three segments; last segment white basally, remainder covered with a dull blackish microscopic pubescence reaching forward to the anal prominence, a triangular extension each side of middle above, often a small spot accompanying each; respiratory tube whitish, spine sometimes projecting.

Length of pupa 9-10 millimeters, diameter 2 millimeters. Light brown ferruginous, obsoletely transversely wrinkled, head and thorax shining, abdomen duller.

Antennal sheaths not very thick at the base, surpassing the marginal angulation above them; carinated tubercles not prominent, lateral notches broad and shallow, palpal sheaths indefinite, rather distant; setiferous tubercles scarcely darker; ocellar tubercles replaced by pale dots. Rima of thoracic spiracles strongly elevated from the inner side, so that the top of the prominence is nearly vertical, the upper edge of the rimal border forming a sharp carina and its anterior extremity ending at the tip of the marginal extension in an acute angle; the free lower edge is crossed by sharp ridges, giving it a separate profile; rima less curved at middle, more strongly at each end, scarcely hooked; inner notch with radiating striations.

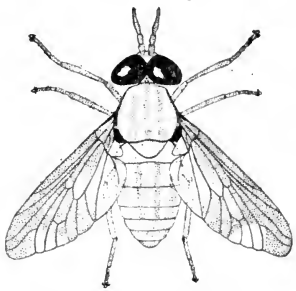

FIG. 8.—Striped earfly (*Chrysops vittatus*), male, enlarged to three diameters.

The abdominal fringes consist of a single row of pale spines on each segment, rather long except dorsally on the second, where they are shorter and thicker. The abdominal spiracular tubercles arise from a single elevation, tapering from a comparatively small base as far as the middle, thence nearly cylindrical to the apex, which bears a subcircular rima; tubercle about as high as its basal diameter. Last segment with six nearly equal terminal teeth, their points marking the angles of a hexagon; slender, even constricted at the base, twice as long as their diameter near the base. Lateral spines almost wanting; ventral fringe in front of anal tubercle in the male; a tuft of about five spines on each side in place of this in the female."

THE LIFE HISTORY OF THE BLACK HORSEFLY.

(*Tabanus atratus* Fabricius.)

This is a common species over a wide range of territory, and has been taken in several sections of Louisiana. In many places it is called the black gadfly, and I have often heard the name "bonepicker" applied to it. This latter name is suggested, I suppose, on account of the ability it exhibits for biting animals in general. It is such a common insect that one might suppose that every item of its life history is definitely known, but such is not the case. It is easy enough to find the eggs in season, and from these it is easy to get the young by hatching, but on account of its long larval period the intermediate stages between the very young and the mature larvae seem not to have been observed. The mature larvae have been collected by many observers and in a variety of places. The first ones were found in rotten logs, and for a time it was thought that they were found only in such places; but they may be procured by digging in the ground in the vicinity of ponds, under stones on ditch banks, taken from the water with dip nets, picked up while swimming on the surface of the water, and frequently in the most unexpected places.

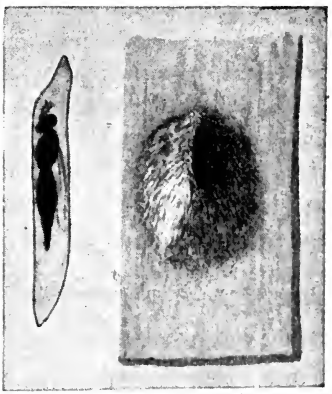

FIG. 9.—Egg-cluster of black horsefly (*Tabanus atratus*), with a single egg showing a parasite within; enlarged. (After Hart, Bull. Ills. State Lab., Volume IV.)

They seem to remain on the surface of the water with the utmost ease, and move from one place to another by their own

efforts, as they can swim much faster than they can crawl when on dry land. They are, no doubt, carried for long distances during periods of high water, either unprotected or in old logs, pieces of rotten wood or in fact in any plant remains of capacity enough to harbor them. Their appearance in places distant from water may often be explained by their transportation during overflows, and it is safe to suppose that the wide distribution of the species is in a measure due to its distribution by the waters of rivers and creeks. It seems probable to me that many larvae reach maturity miles from where they were hatched, and that a mass of eggs placed on a leaf overhanging the waters of such a river as the Mississippi might produce adults for several different States.

Larvae in the breeding cages stop eating in late fall, even though they are kept at a temperature as high as is normal for the summer months. This may be taken as an indication that they hibernate during the winter months when compelled to do so. I have spent some time in trying to gather data on this point, and have found the larvae of the species under consideration in more or less exposed places repeatedly, at the beginning of winter. I have not succeeded in finding them in a frozen condition, as I have larvae of other insects, but there is no doubt that they are often caught by winter frosts in northern climates, and in case they are there seems to be no reason why they should be injured thereby any more than the larvæ of the moths and butterflies. So far as my observation goes, all species of horseflies pass the winter in the larval stage; therefore, the effect of cold on this stage is a subject that should be thoroughly investigated.

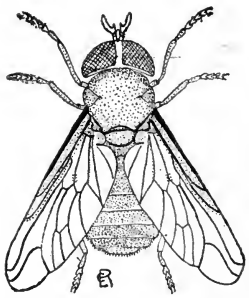

FIG. 10.—American horsefly *(Tabanus americanus)*, female, natural size.

The keeping of the larvæ at ordinary living temperatures all through the winter months does not seem to hasten materially the appearance of the adults in the spring. In many trials with different species in breeding cages I find that the flies issue at about the time that those matured under natural conditions are appearing on the wing. Of course under natural conditions the adults issue continuously over a period of several days, and in some cases over several weeks, so that a comparison like the one just given may be much in error, for the specimens reared in the cages might have appeared naturally toward the latter part of the normal period of emergence.

The eggs are placed in masses of varying size on leaves or stems of sedges and other plants growing in marshy or wet ground, but not necessarily overhanging the water. Single masses may contain as many as 500 eggs, but oftentimes they are much smaller. The egg mass is brownish in color permanently, but when first placed is white, and very convex, being composed of four or five layers of eggs one above the other. Each egg is elongate spindle-shaped, between two and three millimeters in length, and irregularly narrowed at each end. The eggs hatch in about nine days in all cases so far observed.

At first the larvæ are about four millimeters in length, as near as the measurement can be taken, smaller in diameter than an ordinary pin, and pointed at each end. They are colored much like the mature larvae, but if anything the black markings of the body are not so pronounced.

They grow slowly and seem able to pass comparatively long periods without food, but when food is at hand appear to eat almost all of the time. When full grown they measure something like fifty millimeters in length and five or six millimeters in diameter. It is difficult from their general appearance to tell which is the head, for they are pointed at both ends and the body is not plainly differentiated into thorax and abdomen. All the segments for the whole length of the insect telescope on one another, so that it is difficult to give an exact length or diameter. The head end may be located by the direction in which the larva crawls, if in no other way, and the mouth parts will be found to be peculiar and very small. The mandibles consist of two

strongly chitinized hooks, and work by being moved endwise, backward and forward. When drawn in the anterior ends point directly forward, but when protruded these same ends point downward and backward, thus forming a pair of hooks by means of which the larvæ hold their prey, consisting of a variety of invertebrates of various sizes. They are able to protrude these mandibles very quickly, and when they strike a hard object a grating sound is produced. A careful study of the food of the larvae of horseflies is of more than ordinary interest, since it is claimed by some that, as they are predaceous, they may take enough injurious species to admit them to the roll of beneficial insects.

The color of the full-grown larva is dull whitish in general, but there is a conspicuous band of black or dark brown at the union of each two segments. For part of the length the bands of black are but slightly narrower than the others.

In the species under consideration the pupa stage was reached by the middle of May, or before, and lasted about two weeks. It is likely that the change to the pupa occurs much earlier in Louisiana than in Ohio. It may be best to state here that this horsefly is a species which occurs almost continuously during the summer season, so that the date of pupation probably varies with the specimens without regard to seasons. The pupa of this fly is about an inch and a quarter in length.

ON CERTAIN CONDITIONS PRESENT IN LOUISIANA.

Horseflies appear to be very abundant in Louisiana, especially in certain sections, and in the light of what has been said already there seem to be valid reasons for this condition. An atlas which I use for reference contains this statement in regard to the general relief of the State:

"Remarkably low and level, with slight elevations in the west. About 8,450 square miles are subject to overflow, making levees necessary."

The total area of the State is given as 49,626 square miles, so we have figures to show that one-sixth of the entire State is subject to overflow if levees are not constructed. There are many rivers and small streams in nearly all sections, together with many fresh water lakes, and with the swamps and marshes

that go with these, and the isolated depressions filled with water that one often sees in traveling through the domain, we have as favorable breeding grounds for these insects as can be found anywhere.

Some of the area included in the above consideration could be drained, and probably will be some time in the future, but much of it can not be, and, on the whole, it is doubtful if any very large areas will receive relief by drainage, but this remains for future developments to prove.

I have in mind a certain section, not in the State of Louisiana, where mosquitoes and horseflies were exceedingly numerous in past years when the country was being ditched and cleared. At the present time this same section is thoroughly underdrained, no water stands long enough to become stagnant, and these insects are so uncommon that they hardly ever receive consideration. Drainage is a good remedy for horseflies, but there is no use to make such a recommendation for a country where it is impossible to put it into operation.

A section of Louisiana that is especially troubled by horseflies is the section located in proximity to the gulf coast. This whole country is only a few feet above sea level, and the acreage of wet and marshy land is very large. Running nearly parallel to the shore of the gulf is a series of alternating ridges and depressions. The depressions form extensive fresh water marshes, over a part of which the water stands the year round. The rivers that traverse this country are sluggish and at intervals spread out into lakes or extensive marshes. Thus various aquatic animals find conditions to their liking and are present in abundance.

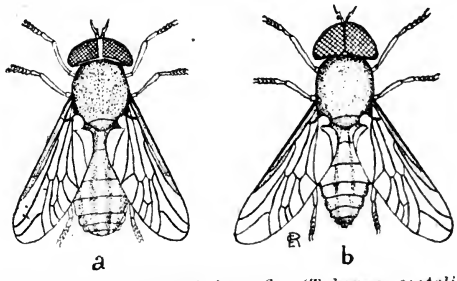

FIG. 11.—Green-head horsefly (*Tabanus costalis*): *a*, female; *b*, male, enlarged to two diameters.

Numbers of cattle and other animals are pastured in this country, the pasturage being furnished both by the marshes and by the higher grounds adjacent. The result is the stock are bitten and tormented by mosquitoes during the night and by the Tabanids and other flies during the day.

THE NATURAL ENEMIES OF THE TABANIDAE.

The natural enemies of this family number several species, belonging to different orders of insects. A knowledge of the life histories and habits of these natural enemies is of value, for the same reason that a knowledge of the life histories and habits of injurious insects is of value. One of the first things attempted when a new insect pest is noted is to work out its life history in detail. When this is accomplished the entomologist is in a position to use his judgment as to when and how insecticides should be applied to give the best results, or if the species is one that will not yield to insecticides, his acquaintance with it will usually give him that information; in other words, a species must be studied in detail before the possibilities connected with its control can be thoroughly and accurately discussed or remedial measures effectively put into practice.

A thorough study of beneficial forms, which include natural enemies of insects, reveals in a sense what they may accomplish under the most favorable circumstances, and, so far as it does this, suggests the advisability of making conditions more favorable for their increase. If a complete account of one of these species is published in an accessible place, acquaintance with it is usually increased, and a general inclination to protect it is in a measure established.

THE HORSE GUARD.

Sphecina (*Monedula carolina* Drury.)

This species is commonly called horse guard where I have been in Louisiana, but E. S. G. Titus refers to it as the "cicada wasp," and says it has frequently been seen killing cicadas.

Much has been written regarding the habits of the predaceous wasps, and surely they are worthy of every consideration as natural enemies of insects and some other invertebrates. They

are considered injurious, beneficial or neutral, according to the habits of the insects or animals they prey upon.

The horse guard has received much discussion from a practical standpoint in some of the agricultural papers, besides being mentioned frequently in entomological journals. While located at the Gulf Biologic Station in June and July, 1905, this species was abundant, and I made some observations on its life history and habits, and especially on the number of flies it carries into a single burrow as food for its young. My attention

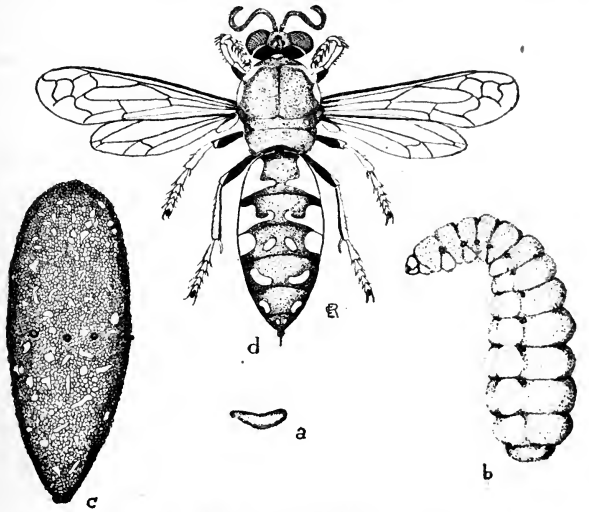

FIG. 12.—Horse guard *(Monedula carolina)*: *a*, egg; *b*, larva; *c*, cocoon; *d*, adult; enlarged to one and a half diameters.

was first attracted to the species in 1903 at the same place, when, for the first time, I observed the adults flying around cattle and horses. I soon saw what they were after, and that they were expert at catching flies from around these animals. It is somewhat amusing to see how peaceably an animal stands when three or four of the wasps are flying around, each making more noise than a botfly or some of the small Tabanids which they show so much nervousness about.

During my stay at the place in 1905 several breeding colonies of the wasps were located and various ages of the larvae were observed in their burrows, together with the remains of flies they had been feeding upon. These colonies were situated in

each case on dry ground where the sand was loose and easy to dig, and on the extent of such ground in one place depended the size of a particular colony.

The eggs are white in color, five millimeters in length and about one-fourth as wide; the form is elongate kidney-shape, and at no time were more than two found developed at the same time in the abdomen of the female. The fact that the larva requires a great deal of food makes it impossible for a female to attend very many, and it seems that the number of eggs produced has a relation to the number of larvae that can be taken care of. The egg was not found in place in the burrow, so that mention of some points that it would be desirable to know must be omitted.

The very young larva, not much larger than the egg, was found in the burrow with a single horsefly, but it was not evident whether this fly had been carried in by the female before or after the egg hatched. The different stages of the larva are much alike except for size; the color is white, the total length of the full-grown specimen is considerably more than an inch; it is very large on the posterior half, but narrows in front of the middle, so that it appears as if the small head is situated at the end of a long neck. The enlarged part remains almost stationary when the specimen is feeding, but the narrowed part possesses great extensile and retractile powers, enabling the well-developed mouth parts to come in contact with every part of the fly it is feeding upon. When one locates the larva in its home he finds it surrounded by the remains of the insects that have been placed before it for food, and the one or two fresh specimens which have just been carried in by the industrious mother; the jaws are continually in motion, and it appears so much taken up with feeding that nothing seems to molest it, but specimens do not take kindly to the artificial conditions of the breeding cage. The body is composed of thirteen segments, not including the head; the first three behind the head compose the thorax, but no feet are borne by it; the remaining ten make up the abdomen; ten pairs of breathing pores or spiracles are plainly visible in longitudinal rows, one row on either side of the body; all the segments except the third, twelfth and thirteenth

bear spiracles. When it becomes full grown the larva makes its own cocoon of earth and silk, united in such a way that the re-

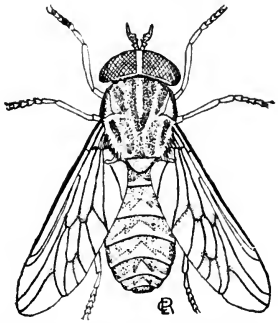

FIG. 13.—Gray horsefly *(Tabanus cymatophorus)*, female, enlarged to one and a half diameters.

sult is a rather dense structure which appears as if moulded from a poor grade of cement. The cocoon finished, the larva remains in it unchanged for some length of time, just how long I have not been able to determine for several reasons.

The cocoon varies in size to an extent that is quite noticeable, and one is led to suspect that the smaller cocoons contain the males and the larger ones the females. It was proven by several observations that the nests which contained the small cocoons had not received as large supplies of food as those containing the large cocoons, and the smaller ones were noticeably lighter in coloration.

The adult is a conspicuous wasp more than an inch in length, with a well-developed sting which she can use effectively in case she gets in a tight place, but she never attempts to protect her nesting site or her young by stinging the intruder, as some wasps do. Both sexes are black in general coloration, with the legs largely yellow, and small spots on the sides of the thorax and larger spots on the abdomen greenish yellow. Several females may have nests in close proximity to one another, but each attends to its own, and on this account the species is often referred to as a solitary wasp, as distinguished from the the hornets and other wasps which form a group known as social wasps. The nest is a simple burrow excavated in the soft sand by the female herself, at least in cases observed, and in this burrow the

egg is laid; when the larva hatches it is fed on flies which she catches and carries to it. Many suppose, when they see this handsome insect flying around horses or cattle, that it is catching food for itself, but in this I suspect they are mistaken, for it is my opinion that the adults feed on the nectar of flowers, on honey-dew from plant-lice and scale-insects and the like, for they commonly visit flowers of various kinds, and they were observed in abundance crawling over the leaves and branches of prickly ash trees thoroughly infested with a common scale- insect (*Ceroplastes cirripediformis*). My belief is that they visited these trees for the purpose of procuring for food the sweet substances which the scale-insects secreted.

It is most interesting to take a position in the midst of a nesting colony of this species and watch the procedure. At first many of the wasps may be seen flying actively on every side, then when all is quiet they settle down to regular routine; some run rapidly over the ground as if searching for the location of their nests, others are making new burrows or cleaning out old ones, while still others appear upon the scene from time to time, each carrying a fly which she takes into her nest as soon as the latter is located and she has satisfied herself that the way is clear. Often a wasp drops her fly for a time, makes an investigation of the surroundings, and then returns and picks it up again.

It appears that when horseflies are to be had the young are fed on them altogether, and as these flies are caught around animals, it is almost always the female, or biting sex, which is taken. The larvae make way with all the soft parts of the flies, but the wings, and very often the head, and more or less of the outer covering are not devoured, so are found in the larval chambers with the immature stages of the wasp. By making a count of the wings of horseflies and other species taken from a single burrow the number of specimens that have been carried into that particular burrow can be determined, presumably with a reasonable amount of accuracy; at any rate, the number can not be overestimated in this manner. The following are records of the counts of material taken from a number of nests:

On July 1 a colony of horse guards was located near the gulf, about a mile to the eastward of the Biologic Station building, and some larvae procured from burrows.

On July 2 Mr. Newell and myself visited this colony, and by means of a wire and hand trowel procured a number of larvæ.

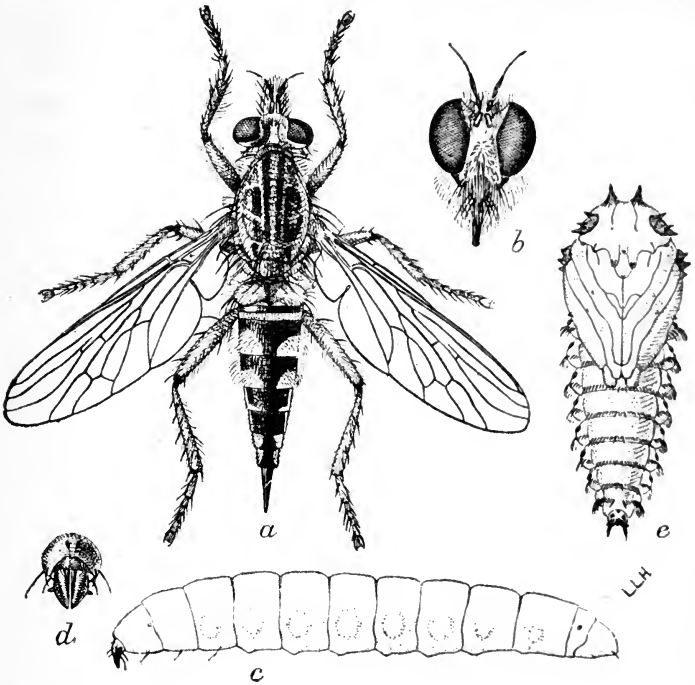

FIG. 14.—A Robber-fly, *Erax lateralis: a*, adult; *b*, face view of the head of adult; *c*, larva; *d*, head of larva; *e*, puparium; all enlarged. (After Titus, U. S. Department of Agriculture, Bureau of Entomology, Bulletin 54.)

In the nests we recognized the remains of three species of horseflies, the screwworm fly and a common green and black fly *(Odontomyia cincta)*.

On July 3 the material found in a single burrow with a nearly full-grown larva was counted, with the result that sixty wings and twenty-three heads of horseflies were found. All the heads were of females.

Another burrow contained ninety-two wings of horseflies and four wings and other remains of *Odontomyia cincta*.

Another contained eighty-two wings of horseflies, but no remains of other species.

On July 4, in company with Mr. W. O. Martin, I visited a colony of wasps on the ridge east of the Station. From a nest

containing a large-sized pupa were taken one hundred and ten wings and forty-eight heads of horseflies, but no other insects. The heads in every case were those of females.

On July 5, I counted the remains of insects taken from a burrow which contained a partially grown larva. This count showed forty-eight wings of horseflies and two wings of a large mosquito (*Psorophora ciliata*). Two specimens of the horseflies were fresh and had every appearance of having been but recently brought to the nest.

On July 14, I unearthed a pupa in the southwest corner of the Station field, and found with it one hundred and twenty-two wings of horseflies and two of another fly *(Pseudopyrelia cornicini)*.

Another pupa taken in the same place had in the burrow with it forty-eight wings of horseflies and six of the screw-worm fly.

I also took a male horsefly in a good state of preservation from a burrow containing a partially grown larva. This is the only instance where the male horsefly was observed among remains found in the nests.

Once in a while nests were found in which the larvae were dead; in at least one instance it appeared as though a certain species of little red ant* was responsible for this condition, for numbers of them were feeding in the nest, both on the dead larva and on the remains of insects found with it. The ant was determined for me by Prof. Wm. M. Wheeler, of the American Museum of Natural History.

The nests are not stored and sealed up as is the case with some wasps, but the flies are carried in by the female as they are needed for food. It appears that the burrow is opened, flies carried in and the burrow closed again. How often this operation is repeated I did not discover, but larvae of all ages, as well as pupae, were taken from closed burrows, and in some of the closed burrows nearly fresh horseflies were found, indicating that the opening had just been filled. When the burrows leading down to the larvæ or pupæ were closed they could be followed by the color of the material used in filling, as this

Solenopsis geminata Fabr.

was usually dryer than the surrounding soil. At different times the females were seen filling the burrows as well as excavating them; the quantity of sand removed and the rapidity with which its removal is accomplished can not help but attract admiration for these wasps, especially when it is known that the larval chamber is usually located six or more inches below the surface of the ground.

THE SMALL HORSE GUARD.

(*Bembex belfragei* Cresson).

This is a member of the same family as the last, but is a much smaller insect. So far as observed, its habits and life history are similar; its burrows are made in similar locations and the food of its larvæ is composed of different species of Diptera, a large proportion being horseflies. A difference is noted, however, in the places where it procures these horseflies, for, instead of catching them almost entirely around stock, it picks them up in the marshes and fields, not hesitating to fly out over the water to procure specimens that it finds clinging to grasses and sedges. Therefore the male horseflies are taken much oftener than by the horse guard. In 1903 this species appeared to be much more common than in 1905. It is one that should be widely known and given as much protection as possible.

SAY'S SPOTTED WASP.

(*Crabro* 10-*maculatus* Say.) = *Ectemnius chrysargyrus* L. & B.

This is another of the solitary wasps which has been observed catching horseflies. Its nest was not located, but it is known that various species of its genus make their nests in woody plants, especially raspberry and blackberry. Peckham found that another wasp of this genus (*Crabro stirpicola*) provisioned its nest with various species of flies.

THE HORSEFLY EGG-PARASITE.

(*Phanurus tabanivorus* Ashmead.)

Some years ago Hart reared this parasite from the eggs of our large black horsefly.* There is probably more than one

Tabanus atratus.

brood of this species in a season, for Hart's specimens issued in August and September, while I have bred specimens which issued in July. This is a very small insect, and passes its immature stages inside the eggs of the fly, one specimen in each egg. At a certain place in Medina County, Ohio, where the eggs of the black horsefly were common, it was found that many of the masses remained plump long after others had shriveled because of the larvae hatching from them. An investigation showed that

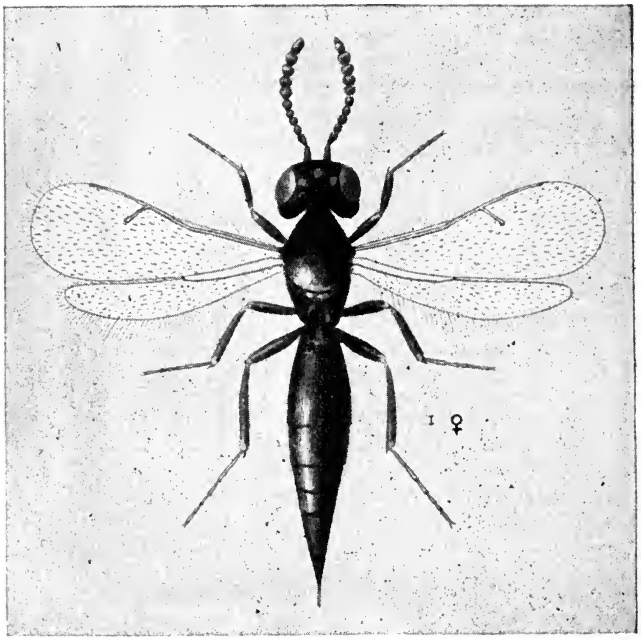

FIG. 15.—Horsefly egg-parasite, *Phanurus tabanivorus*, much enlarged. (After Hart, Bull. Ills. State Lab., Volume IV.)

the former contained many parasitized eggs, some masses having nearly every specimen in this condition. A number were collected and put into small vials, where, in the course of a couple of weeks, hundreds of the parasites issued. What I have observed regarding this minute species proves to my mind that it is of much importance in lessening the numbers of horseflies whose eggs it infests. It has not been observed in Louisiana, but

since its host is common in the State there is scarcely any doubt but that it is there and can be found at the proper season. Another species of this same genus, occurring in Europe, is known to have similar habits.

There are a number of other species of Hymenoptera that have been observed to be natural enemies of the horseflies, and these, as well as the ones mentioned, should receive further study, so that the benefits derived from them will be better understood and the possibilities of utilizing them realized as far as possible.

THE ROBBER-FLIES.

These belong to the order Diptera, as do the horseflies. The robber-fly known as *Erax lateralis* Macquart is common where I have been in Louisiana, and is a regular hawk among insects, frequently capturing the smaller members of the genus *Tabanus*, as well as other insects. It does not appear, however, that the robber-flies are of as much importance in this connection as the wasps, for the reason that the adults do not attend their larvae during growth, and hence capture insects for their own food only. As the robber-fly larvae are predaceous and live in the ground, they have an opportunity to capture other larvae that live in such situations, and therefore they may devour an occasional immature horsefly.

There are scores of species of large flies belonging to the same family as the one just named, and all of them procure their food in the same way that it does. They are cunning insects, remaining perfectly quiet in some inconspicuous place until an insect that they desire for food comes close enough, when they pounce upon it and by means of their strong legs, which are provided with sharp claws, retain it until they introduce their mouth parts and suck away its life-blood. Species of the genus *Deromyia* were especially conspicuous in the fields in the vicinity of the Gulf Biologic Station, and they were often seen capturing horseflies for food.

In a complete report on the natural enemies of horseflies, the large dragon flies and various species of Hemiptera, or true bugs, should receive consideration. Spiders often catch the adult

horseflies in their webs, or by jumping upon them from concealment among the foliage. Many birds include them as part of their food, and various insects have been observed feeding on the egg-masses.

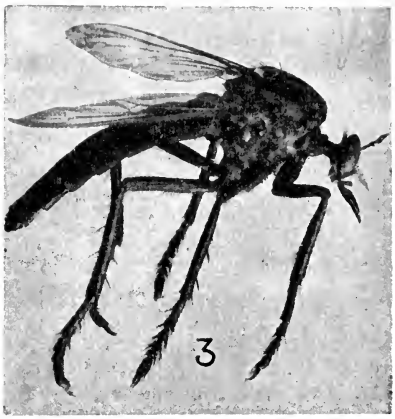

FIG. 16.—A Robber-fly, *Deromyia angustipennis*, enlarged. (After Quaintance and Brues, U. S. Department of Agriculture, Bureau of Entomology, Bulletin 50.)

Before leaving this subject it may be well to give brief consideration to a few species of fishes whose habits suggest that they have some connection with the subject. The top-minnow* was observed to be common in Louisiana in both brackish and fresh water, and is one of the species Dr. L. O. Howard figures in his "Mosquito Book" as feeding upon mosquito larvae. It is not large enough for use as food, but flourishes in small ponds as well as in larger bodies of water, and its small size is an advantage, enabling it to go into the shallowest places. The species is viviparous, each female giving birth to a number of living young, which, it is stated, can be reared with the greatest ease, it being necessary only to keep them in water where they can procure sufficient food. Other fishes closely related to this one have similar habits and should receive attention. Professor Garman reports, in Volume III of the Bulletin of the Illinois State Laboratory of Natural History, that the larvae of horseflies are eaten in quantities by the channel catfish and occa-

* *Gambusia affinis.*

sionally by the bull-pout. Various species of sunfish are common in Louisiana waters also, and on account of their strictly carnivorous habits, in most cases at least, they are most desirable. The people should see to it that all permanent waters, no matter of what extent, are well stocked with fishes, not only on account of the larvae of horseflies destroyed by them, but for many other reasons as well.

ARTIFICIAL REMEDIES FOR HORSEFLIES.

Up to the present time no satisfactory remedy applicable in all cases has been suggested, for the habits of the various species are such that it is difficult to suggest anything that can be applied in a practical way.

The method, long in use, of protecting work animals with fly nets meets with quite general satisfaction, and the use of burlap on other choice animals has its merits, but the problem of how to protect the stock in the pastures is the important one, and its solution is not easy. In order to solve this problem a general remedy for horseflies in some stage must be suggested, and since it is the adults that do the damage, a remedy for them is most desirable.

If one takes the time to observe these flies around water when they are plentiful, he soon notices that certain species, at least when flying over the water, drop down now and then and dip their abdomens. Porchinski of Russia explains this habit by saying that the flies come to drink, and that every time they drop down to the surface of the water they take a sip of the liquid. He also made a number of experiments, and proved that by applying kerosene to the surface of standing pools large numbers of horseflies of various kinds got the oil on their bodies while drinking, and were killed. As to the quantity of kerosene required to kill them in this manner, it is stated that he applied about the equivalent of a half-pint to six square feet of water surface. If this was sufficient to do the work, no more oil was applied until the next morning, when a like amount was used. In case the first male horsefly that came to drink did not stick to the surface, more oil was applied immediately. He observed that all the species of *Chrysops* and *Tabanus* which were

flying at the time of his experiment were killed by the application. A translation of Porchinski's article, with additional notes by Dr. Howard, is published in Bulletin 20, United States Department of Agriculture, Division of Entomology, 1899. In an investigation of this method I find it has merit in the right place, but too often all the water of a locality is in swiftly flowing streams, where such an application is not effective.

The method of applying some oily or ill-smelling substance to stock for the purpose of repelling the flies has been in use for a long time, but the main objection to it is that a single application does not last long enough. Kerosene emulsion,* diluted with two parts of water, with the addition of a little carbolic acid, has received favor in some sections. This may be applied with an atomizer or hand sprayer. A small atomizer that will throw a very fine spray may be had from different manufacturers and dealers for about a dollar, and with such a device one can go over an ordinary-sized herd of cows in a few minutes.

Several prepared mixtures are on the markets, and Mr. S. J. Baldwin recommended the following in the Ohio Farmer for August, 1904: Kerosene, 3 gallons; pine tar, 1 quart; carbolic acid, 1 pint. These may be applied in the same way as the above.

All of these mixtures, when properly applied, kill many of the common flies,** such as the horn-fly and others which usually cling to the animal until the application is made. The horseflies, however, will not remain long where the atomizer is in operation, consequently the repelling properties of these substances are practically all that are effective.

When in Louisiana in 1903 my attention was attracted by the large number of horseflies that entered the Station

*Kerosene emulsion can be made from 2 pounds of whole oil (or good laundry) soap, 4 gallons of water and 8 gallons of kerosene, as follows: Weigh the soap carefully and place with the water in a vessel over the fire, using a slight excess of water to make up for evaporation. Fit a pump with a straight piece of hose, to which is attached a nozzle for throwing a straight stream 3-16 or 1-4 inch in diameter. Pour the oil into a barrel or tub in which the pump is set, and when the soap is dissolved and the solution begins to boil, add it to the oil *(away from the fire)* and pump the whole vigorously back into itself for a period of at least ten minutes. The stream from the nozzle should be directed straight downward into the mixture so as to agitate it to the very bottom. After a few minutes the oil and soap solution will be seen to combine, forming a thick creamy solution which, when perfectly made, will remain without change for several days. For a 20 per cent. strength add water to make a total of 40 gallons; for a 15 per cent. strength add water to make 54 gallons, and for a 10 per cent. strength add water to make 80 gallons, and agitate thoroughly before use.

**Of the Family Muscidae.

building at Cameron when the screens were left open at the time of day when they were flying; and Mr. M. W. McCall stated he had noticed the same thing in previous years. The three species common at Cameron are *Tabanus lineola* (lined horsefly), *T. 5-maculatus,* and *T. costalis* (green-head horsefly), and are the ones upon which my observations were made. The Station building is much the largest building in the locality, is constructed in the form of a cross and is painted a clear white. I have never fully satisfied myself as to the reason for this strange behavior of the flies, for there may be two or three reasons for it. They may be attracted by the white color of the building, or by the shade which it affords, or they may possibly enter it through a desire to secure protection from their enemies. The flies that entered a doorway, about 5x7 feet, in five hours' time, on August 23, when killed nearly filled a quart measure, and almost all of them were females. This observation suggested that a trap might be constructed that would accomplish similar results, and accordingly, in 1905, the trap was built, but by the time it was ready the horseflies were almost gone and did not appear in sufficient numbers again while I was in that locality to give me an opportunity to observe its workings.

While preparing a paper on the Tabanidæ of Ohio, it was suggested that, since many horseflies lay their eggs over water, and also since the larvæ from these eggs must drop into the water when they hatch, kerosene on the surface of the water might be used to kill these immature forms, and a measure of success was obtained when the oil was used on stagnant ponds.

Since, as shown above, various species are very uniform in placing their eggs, there may be times when a systematic gathering of these will give practical results. It is often possible to find places where as many as 60,000 may be gathered in a single hour. This would be practical, if at all, in a country where there is only once in a great while a place for these flies to oviposit.

THE SPECIES OF HORSEFLIES KNOWN TO OCCUR IN LOUISIANA.

Most of the species of horseflies thus far taken in the State were collected by Mr. Newell and his assistants, Messrs. Hardy, Garrett, Martin and Flynn, during the summer of 1905. Some, however, were taken in former years by Prof. E. L. Moseley, of Sandusky, Ohio, who has a plantation in West Carroll Parish, and a number of specimens have been received from Mr. Charles W. Johnson, of the Boston Society of Natural History. The writer has also collected in the southwestern part of the State in two different seasons. As stated, the species taken belong to two genera, *Chrysops* and *Tabanus*. The first includes the small flies commonly called earflies, woodflies or similar names, while the latter includes the others, all of which are larger in size. The horseflies proper belong to the genus *Tabanus*, and are readily distinguished from the species of *Chrysops* on account of larger size and the absence of small spines at the end of the posterior tibiæ.

CHRYSOPS FLAVIDUS Wiedemann (Brown Earfly). This is perhaps the most common member of this genus on the Louisiana gulf coast, and it has frequently been taken in other parts of the State. The species is almost uniformly brownish all over, but some irregular dark markings are present on the abdomen, and there are four narrow gray stripes on the thorax. The two sexes are much alike, except that in the male the brown markings of the wing are more extensive. The wing in both sexes is brown and subhyaline.

The following observations made by Mr. Newell serve to give an idea of the importance of this fly:

"At Cameron, on June 9, 1905, I found a number of specimens inside the slat-work around the cistern at the Gulf Biologic Station. This was about 5 o'clock in the evening. A few were also found on the walls of the Station building and on the outside of the window screens. About twenty specimens were caught. Just after sundown I went out through the long grass to the beach, and while in the grass plat was attacked by at least a dozen specimens. They do not buzz around preliminary to biting, but sail right in like a hornet, and bite as soon as they alight. They show no fear when making an attack and can be caught easily when they have once alighted on clothing or flesh. The bite is painful, often followed by a slight swelling and a severe itching. During the middle of the day they are

shy and somewhat hard to capture. Specimens occasionally attacked one for some time after sundown, both around the laboratory and near the hotel. Mr. Martin, who was collecting in the marsh east of the laboratory at sunset, the same day, was also severely bitten by them.

On the morning of June 10, I found but one or two individuals inside the lattice work surrounding the cisterns, where a couple of dozen were taken the afternoon previous. About a dozen were seen on the walls of the Station building. Prof. Guilbeau, who has spent three summers at the Station, had never observed this species so abundant as at the present time. Both Messrs. Cary and McCall say that this fly had not been annoying the present season until their appearance in numbers on June 9. In fact, they had not been noticed at all, but this may have been due, in part, to their not having attacked people so viciously prior to this time. Evidently the adults were appearing in greatest numbers, or else were daily becoming more abundant. On the afternoon of the 10th, about 4 o'clock, I was attacked by three or four specimens while near a muddy pond east of the Station. About 2 o'clock I thoroughly swept over the grass lot where the flies were so abundant the evening before, thinking that possibly they spent the day hiding in the grass. Not a single specimen was obtained, but since the grass was very high, the flies might not have been caught if they had been present and near the ground.

On June 11, we were occasionally attacked by one or two flies at different times during the day, especially when near brush or timber, and this made it appear that they sought sheltered places during the middle of the day. On the following day we were again attacked by several specimens while collecting in a cotton field about 9 o'clock in the morning. The species did not appear, on this date, to be as abundant as on the 9th."

CHRYSOPS OBSOLETUS Wiedemann. This species has a wide range and is often abundant. It is usually encountered along the edge of woods where the females are annoying pests. The color of the fly is black, with the wings partially hyaline and with usually a yellow stripe on the middle of the abdomen, although there may be variation in the color of this last. Specimens were taken by Newell at Forest-hill, on September 8. It usually occurs earlier in the season than this.

CHRYSOPS PIKEI Whitney (Little Earfly). This is a rather small species, about the size of the common house fly. It was recently described from specimens taken in Pike County, Missouri. The thorax is black, with four narrow yellow stripes; the abdomen may be described as yellow, with four black stripes, but the one on each side disappears on the first two segments. Judging from the number of specimens taken during the latter part of August and the first part of September, the species must be very common. They were taken

in other months also. Following are some of the records of capture: Many, May 19 (Newell); Montgomery, June 29; Gloster, July 14; Frierson, July 14; Keachie, August 23; Logansport, September 6 (Garrett); Foresthill, September 8 (Newell).

The following observations on this fly were made by Mr. Garrett:

"These insects were numerous and very annoying in the vicinity of Logansport. They almost invariably attacked horses' ears and very frequently left them covered with blood. They were most numerous near creeks and bayous, but were found to some extent in higher places."

CHRYSOPS VITTATUS Wiedemann (Striped Earfly). This is a common species all over the eastern United States, and was taken in many localities in Louisiana the past summer. It is usually larger than the last two species mentioned above, but is about the same size as *C. flavidus*. In general appearance it is more yellowish than most species of its genus; the stripes on the thorax are bright yellow and conspicuous; the black stripes on the abdomen are narrow and composed of a series of elongated spots joined end to end. The following records indicate its general distribution and time of appearance: Montgomery, June 29; Gloster, July 14; Lecompte, June 8 (Hardy); Logansport, September 8 (Garrett); Foresthill, September 8 (Newell).

The following observations upon its habits were made by Mr. Newell:

"During several days of traveling through southwestern Rapides Parish, between Lecompte, Woodworth, Foresthill and Glenmora, I encountered this species wherever low or swampy valleys were crossed, especially where the growth of underbrush was dense. The flies attacked the necks and ears of the horses, both being often covered with blood from their vicious bites. In a swampy area on "Spring Creek," southeast of Glenmora, I counted as many as twenty-five on the ears of my horse at one time. This species was not found in the long-leaf pine timber, but only in the creek bottoms running through the 'piney woods' country. This fly evidently does not attack man, as at different times I approached large numbers of them flying about the horses' heads, for the purpose of capturing specimens, but was not once bitten. After a few individuals were captured the rest usually became alarmed and flew away. The individuals which were engorging themselves with blood, on the other hand, showed no fear and stuck so tenaciously to the animals that it was almost impossible to remove them without injuring them as specimens."

TABANUS ATRATUS Fabricius (Black Horsefly). This large black horsefly is generally distributed over the eastern United States, and as far west as Colorado. It is entirely black, wings and all, and

on this account it is easily recognized. This species has been taken during the past summer as follows: Logansport, June 25; Negreet, May 19; Cameron, August 23; New Orleans, August 29. A discussion of this species and its habits was given on a previous page.

TABANUS AMERICANUS Forster (American Horsefly). This is our largest North American species. It is restricted in its distribution to the southeastern United States. The color is red, the wings are hyaline with a narrow front border which is pure brown. Its bite is severe, but the species does not usually appear in numbers sufficient to make it as serious a pest as some of the smaller species. Specimens were taken at Montgomery, June 29.

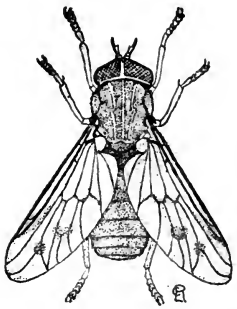

FIG. 17.—Brown horsefly (*Tabanus benedictus*), female, natural size.

TABANUS BENEDICTUS Whitney (Brown Horsefly). This species was but recently described from specimens taken in Missouri. It is a large species, about the size of *T. atratus*, which it resembles somewhat, but the body is dark-brown and the wings are subhyaline. It does not appear to be as abundant as some of the other species, but has been reported as injurious to driving-horses. Taken at Crowley, June 17; Montgomery, June 29; Frierson, July 14.

TABANUS SULCIFRONS Macquart (Autumn Horsefly). This is somewhat smaller in size than the species of *Tabanus* named above. The thorax is marked with narrow gray stripes, the abdomen is reddish above, with a median longitudinal row of white triangles, and the wings are subhyaline with a number of small brown spots. It is distributed generally over eastern North America and is one of the most abundant and annoying pests of the Family Tabanidae. It is one of the late-appearing species, being abundant when many other species have nearly disappeared. Specimens were taken at Lecompte, September 7 (Newell); Logansport, September 6; Keachie, October 16 (Garrett).

Mr. Newell made the following observations upon the habits of this fly:

"In driving through the 'piney woods' country (uplands), west of Lecompte, from the 1st to the 7th of September, I found this species fairly abundant. From three to fifteen were constantly following the team while in the pine uplands and many were captured. They would frequently fly into the buggy and alight on the underside of the top. Along creek bottoms and in swamps they were not nearly so abundant as in the uplands, occurring only occasionally. In addition to their attacking horses, I noticed them on mules, cows, sheep, and in one case attacking a cat. They did not bite persons, although they were offered many opportunities. They were rather shy and difficult to capture. When we were attempting to catch individuals around the team, frequently all of them would leave to return again as soon as the collector moved away a few feet. I noticed that this species, when flying over water, would frequently drop to the surface, and after striking it with the body, quickly dart away again."

Mr. Garrett reports that this species was abundant at Keachie from July all through September and October, and that it was practically the only species of *Tabanus* found in that locality during the two latter months. During the entire time that it was abundant Mr. Garrett noticed that the flies entered a farm house in that locality in considerable numbers and collected upon the screens inside of the house, similar to the manner in which the Tabanids did in the laboratory at Cameron. Large numbers of them had died of starvation and had collected in masses upon the window sills and entirely filled the space between the window sill and screens.

TABANUS MEGERLEI Wiedemann. This species has the eyes pilose and is the only one of its group thus far taken in the State. The thorax is dark colored, but with indications of gray stripes; the abdomen is reddish with a wide black stripe down the middle; the wing is blackish at the base, but the apical half is mostly hyaline, with a black dot on the cross-vein and at the forking of the third vein The species usually appears early in the season and the single specimen taken in Louisiana is no exception. It was taken on the Experiment Station farm at Calhoun, April 7, from mules in the field (Newell). Previous records indicate that this species was known from Florida only.

TABANUS VENUSTUS Osten Sacken (Spotted Horsefly). This is one of the most distinct species of its genus found in the State, and there is no other fly that can be confused with it. The thorax is plainly striped with gray; the abdomen is black, with a middle row of distinct white triangles. The wings are variegated with hyaline and black, the two being nearly equally divided. The coloration of

the wings readily distinguishes the species. Taken at Logansport, August 19 (Garrett).

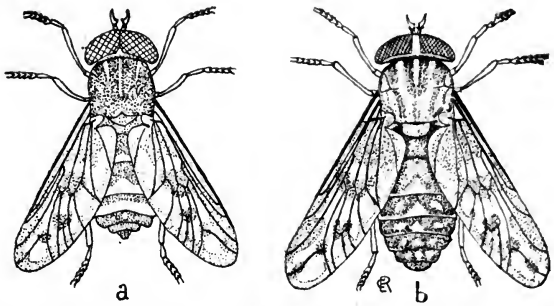

FIG. 18.—Spotted horsefly (*Tabanus venustus*): *a*, male; *b*, female; enlarged two diameters.

Mr. Garrett says this species seemed to be very scarce in the vicinity of Logansport, for special attention had been given to all horseflies noticed while traveling through the country, and only four specimens of this particular species had been captured. Three of these were captured at the same place, in the edge of an old field grown up with young pine trees. Two of the three were captured on August 19 and the other one on September 6. The fourth was captured near Mansfield on September 9.

This species was previously known from Texas, Kansas, Oklahoma and Ohio. It appears to be abundant in parts of Kansas and is said to be a pest of considerable consequence.

TABANUS COSTALIS Wiedemann (Green-head Horsefly). Thorax yellowish, without stripes; wings hyaline with the front border yellow or brown; abdomen with a distinct median stripe and a stripe, more or less distinct, on either side. Length, slightly more than half an inch. In addition to its occurrence at Cameron, mentioned below, it was taken at Robeline, May 25 (Garrett); Lake Charles, June 13 (Martin); Keachie, June 14 (Garrett); Crowley, June 17 (Martin).

TABANUS 5-VITTATUS Wiedemann. Thorax yellowish with indications of stripes; wings hyaline with brown veins; abdomen usually with three grayish stripes separated by brown stripes of nearly the same width. Average length about two-thirds of an inch.

TABANUS LINEOLA Fabricius (Lined Horsefly). Thorax more brownish than yellowish, showing three narrow whitish lines, which are more distinct anteriorly; wings hyaline with brown veins; abdomen with a distinct median gray stripe, and on each side an irregular gray stripe formed of elongate oblique spots. Same size as *T. costalis*.

The three species just named are the common ones at Cameron, where the Gulf Biologic Station is located. Probably the first is the

most important from an economic standpoint, for it is very persistent in its attacks upon stock. It habitually alights on the under parts of animals, where they have difficulty in reaching it, and it is therefore almost sure to satisfy its appetite before leaving. However, all three of these species are important stock pests. They fly at the same time and in the same places and are often mistaken for one and the same insect. They flew around the laboratory building in great numbers and could be seen resting on the siding and windows at almost any time during the day. If the screens were allowed to stand open they entered the building in numbers and eventually collected on the windows, where they died of starvation.

The three species just considered all have stripes on each side of the abdomen, while the three following species have rows of rounded spots on each side of the abdomen.

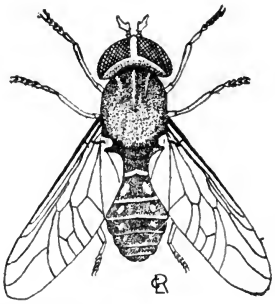

FIG. 19.—Little horsefly *(Tabanus pumilus)*, female, enlarged to three diameters.

TABANUS PUMILUS Macquart (Little Horsefly). This is one of the smallest species of its genus, being only about one-third of an inch in length. Thorax black, with narrow gray stripes. Narrow gray posterior border of each abdominal segment expanded into a very small triangle at the middle; thus the abdomen has a median row of small gray triangles, and on either side of this a row of small gray spots. Wings hyaline. One specimen taken at Leesville, April 28, 1905 (Newell). This species is also distributed over the eastern United States.

TABANUS SAGAX Osten Sacken. Femora blackish; thorax uniformly yellowish, without stripes; wings narrowly yellowish on the anterior margin, otherwise hyaline; abdomen with a rather prominent median dorsal band and a row of rounded spots on either side. One-half inch in length, some specimens larger. This species has been taken at several places in the eastern United States. Captured in Louisiana at the following places: Shreveport, June 14 (Newell); Frierson, July 14; Logansport, September 6 (Garrett).

"On June 14, 1905, while coming into Shreveport on the Kansas City Southern Railway, and while standing on the rear platform of the last car, I noticed two of these insects following the train, and occasionally alighting upon the coach. The train was running about twelve miles an hour and was a few miles out of Shreveport. I succeeded in capturing but one of the two specimens." (Newell).

Mr. Garrett made the following note at Logansport on September 6: "These flies usually attack the horses' legs and are quite annoying, for when they have once settled the horse can hardly get rid of them. They are quite numerous at this date."

Again: "These little insects were taken from the legs of horses which were being driven to a buggy. They usually alight on the horse's leg between the hock and the hoof, and are rather difficult for the horse to drive off, which he usually tries to do by stamping or kicking."

TABANUS FULVULUS Wiedemann. Length, three-fifths of an inch. Some specimens are larger and some are smaller. Thorax without stripes; wings with the anterior margin narrowly yellowish, but otherwise hyaline; abdomen with a median dorsal band and a row of spots on each side, whitish or yellowish. It differs from *T. sagax* by having the femora yellowish instead of blackish, and the third segment of the antenna is not so plainly angulated above as in that species. It is known from Kentucky, Maryland, North Carolina and New Jersey, and appears to be common near the seacoast. Taken from a horse that was being driven to a buggy, June 17, 1905, near Crowley, in the southern part of Louisiana (Martin).

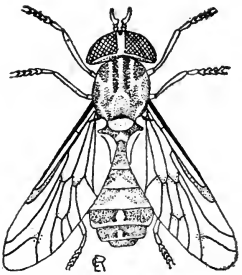

FIG. 20.—Say's horsefly *(Tabanus molestus)*, female, enlarged to one and a half diameters.

TABANUS MOLESTUS Say (Say's Horsefly). The thorax is dark-brown, plainly striped with gray; the abdomen is black, with the posterior margin of each segment narrowly gray, expanding into a prominent triangle at the middle of the third, fourth and fifth segments. There is also a small triangle on the second segment, but it is so small in comparison with those on the following segments that it is hardly noticeable. Wings subhyaline, veins brown, but not margined

so as to form distinct brown spots. The species is widely distributed over the southeastern United States. In Louisiana it has been taken as follows: Negreet, May 19; Leesville, June 2 (Hardy); Merryville, June 2 (Martin); Houghton, June 20, 1905 (Garrett). So far as observed the adults occur in the early part of the season only. The larger specimens are seven-eighths of an inch in length, but the Louisiana specimens I have seen are somewhat smaller.

CONCLUSIONS.

Since there is a great deal yet to learn about horseflies, it seems proper to call attention to a few points worthy of special consideration.

Predacious and parasitic insects which prey upon horseflies are capable of doing much towards checking the ravages of certain species. Who knows but what these natural enemies of the flies could accomplish much more if conditions were more to their liking? The work of the horse guard *(Moneduba carolina)* is especially efficient, and since it appears that this species thrives in certain sections where there is sand for it to make its nests in, could it not be introduced into places where it is not known at the present time? If more were known of its habits and requirements, life history and enemies, it might be possible to increase its numbers in sections where it is now present but not plentiful enough to do the work desired of it.

Before it is possible to speak intelligently concerning what may be accomplished in the way of combatting any injurious insect or group of insects, a full knowledge of each species is usually necessary. The codling moth of the apple could not be handled successfully until a careful study of its life history showed that the young insect entered the calyx end of the apple in the spring, and that if this part of the apple were thoroughly sprayed with the proper mixture before entrance was effected, it would receive a fatal meal the first thing; but that if spraying were deferred until after it entered, the insect could not be reached.

Not over a dozen of the North American horseflies are known in their immature stages, the eggs of less than ten species have been described, and the larvæ of some of the most abundant and injurious forms remain unknown. When we consider that

the first larva of an American horsefly was described more than thirty years ago, and that since that time many economic entomologists in all parts of the country have been investigating all manner of subjects with which insects are concerned, we hardly know how to explain the fact that so little is really known about these stages.

If all species were alike in their habits, a knowledge of the immature stages of one species would make it an easy matter to work out the life histories of the others. The fact that so few have been worked out is proof in itself that all species are not alike; and when one undertakes the study of a particular species, in addition to those with which he already claims an acquaintance, he is not only convinced that the immature stages of two species may be different, but that they may have scarcely a single habit in common.

Horseflies are a recognized pest in all parts of the world, and although it is difficult to estimate the damage done by them, every farmer and stock-raiser admits it to be considerable. It is a fact that all remedies that have been suggested are unsatisfactory in a measure, but it is quite possible that by continued study and investigation of the problem effective remedial measures may be developed.

The State Crop Pest Commission of Louisiana

Was established by the Extra Session of the Louisiana Legislature of 1903, by Act No. 6, Approved December 15th, 1903, for the purpose of promulgating and enforcing Rules and Regulations intended to prevent the introduction and dissemination of insects and diseases inimical to the crops and fruits of the State, to investigate seriously injurious insects or diseases occurring within the State, to devise ways and means for their control or eradication and to publish bulletins and in other ways disseminate information regarding the insects and diseases injurious to fruits, crops, etc.

The Circulars of the Commission are issued from time to time as the result of the investigations being made and whenever such publication is deemed advisable in order to place reliable information in the hands of planters, fruit-growers and farmers regarding certain injurious insects or diseases. These Circulars are sent free of charge to all farmers and fruit-growers in the State who make application therefor. Applications for these Circulars, as well as for copies of the Regulations of the Crop Pest Commission, or of the Act No. 6 establishing the Commission, when these latter are desired, should be made to the Secretary of the Commission (Baton Rouge, La.).

Circular No. 3, November, 1905, contains a discussion of the cultural remedies to be used against the boll weevil and should be secured by every cotton planter and farmer in the State of Louisiana.

Circular No. 4, December, 1905, describes the San Jose scale, a serious insect enemy of fruit trees, and gives the means by which it may be controlled. All fruit-growers should write to the Secretary of the Commission for a copy.

Circular No. 5, January, 1906, contains a general discussion of the boll weevil situation, and the lines along which Louisiana's campaign against this insect is being conducted.